New Scientist

WEEKLY 12 July 2025

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IS AI ABOUT TO TRANSFORM HOW WE DO MATHS?

SINGLE DRUG COULD PREVENT ALL FLU STRAINS

WHY WE AGE IN 3 RAPID BURSTS

... and can we do anything about it?

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This week's issue

On the cover

30 Why we age in 3 rapid bursts
... and can we do anything about it?

34 I let an AI agent run my day
What could possibly go wrong?

Vol 267 No 3551
Cover image: Paul Blow

10 Meet the first known human-Neanderthal child

8 Is AI about to transform how we do maths?

16 Single drug could prevent all flu strains

10 Third interstellar visitor **19** Ancient Rome's secret sauce recipe **15** The tree that turns air into stone

38 Features

"We evolved to compete in a cooperative world"

News

9 Light pollution
Nighttime light increases your risk of heart disease

11 Power failure
Hackers could use home solar panels to disrupt power grids

13 Historic breakthrough
The complete genome of an ancient Egyptian has been sequenced for the first time

Views

21 Comment
A plan to genetically prescreen newborns is problematic, says Suzanne O'Sullivan

22 The columnist
Chanda Prescod-Weinstein considers cosmic distances

24 Aperture
A stunning octopus image

26 Culture
Controversial book warns of plummeting global population

29 Letters
We do have free will, but we are squandering it

JUAN BARRETO/AFP VIA GETTY IMAGES

17 Sea change Antarctic sea ice loss is more damaging than we thought

Features

30 Ageing, fast and slow
Ageing isn't a slow, steady decline, but rather occurs in three rapid bursts

34 AI at your service
Find out what would happen if you let an AI assistant run your day

38 The enemy within
Are humans more competitive or cooperative?

The back pages

43 The science of exercise
The benefits of isometric exercises

45 Puzzles
Try our crossword, quick quiz and logic puzzle

46 *Almost* the last word
Why not hover above Earth until it rotates to your destination?

48 Feedback
Academic insights into human-robot intimacy

48 Twisteddoodles for *New Scientist*
Picturing the lighter side of life

Elsewhere on New Scientist

NS Live

How gaming changed the world

Below the surface of our vast gaming culture is a story of technological innovation. On 18 October at Excel London, future-tech researcher Andy Miah will guide you through the remarkable achievements that have arisen through video games, from *Fortnite* and *Pokémon GO* to *Minecraft*.

newscientist.com/nslive

Tour

Human origins: Neolithic and Bronze Age Turkey

Discover how Neolithic and Bronze Age people in Turkey changed from hunter-gatherers to organised societies with agriculture, ritual and an understanding of the wider world. Guided by an expert archaeologist, you will uncover the mysteries of Turkey's ancient landscapes. This 12-day tour starts on 24 September and costs £4550.

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Podcast

The world, the universe and us

This week, the team discusses the first complete genome of an ancient Egyptian – a man who lived more than 4000 years ago. Discover what gifts orcas have been giving to humans. Plus, find out about the first demonstration of interstellar navigation and the new object that has just been spotted entering our solar system.

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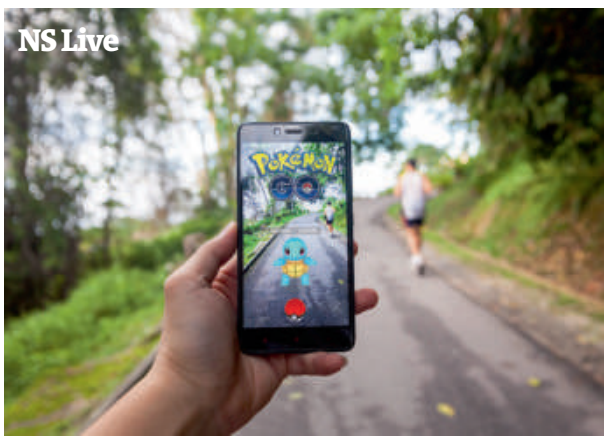

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Play time Discover how video games drive technological innovation

IMAGEBROKER.COM/ALAMY

Ancient lands Explore Turkish sites like the statues of Mount Nemrut

Video

How ash trees are combating deadly dieback fungal invasion

Research by scientists at the Royal Botanic Gardens, Kew and Queen Mary University of London indicates that natural selection is acting to combat ash dieback, a fungal disease that has devastated ash trees across Europe. The discovery offers hope for the survival of these trees in the future.

youtube.com/newscientist

Newsletter

Lost in Space-Time

Where time comes from is a popular question, with no set answer. The arrow of time, a concept that dates back to the 1920s, stems from the laws of physics that describe energy, heat and entropy. Karmela Padavic Callaghan explains how it can teach us about the universe's beginning – and its end.

newscientist.com/lost-in-space-time

Newsletter

"Time's arrow will push me into a future where I have more conversations about it"

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An issue of trust

Will we ever feel comfortable with AIs taking on important tasks?

IMAGINE a map of the world, divided by national borders. How many colours do you need to fill each country, plus the sea, without any identical colours touching?

The answer is four – indeed, no matter what your map looks like, four colours will always be enough. But proving this required a schism in mathematics. The four colour theorem, as it is known, was the first major result to be proved using a computer. The 1976 proof reduced the problem to a few thousand map arrangements, each of which was then checked by software.

Many mathematicians at the time were up in arms. How could something be called proven, they argued, if the core of the proof hides behind an unknowable machine? Perhaps because of this pushback, computer-aided proofs have remained a minority pursuit.

But that may be starting to change. As we report on page 8, the latest generation of artificial intelligence is turning this argument on its head. Why, ask its proponents, should we trust the mathematics of flawed humans, with their assumptions and shortcuts, when we can turn the verification of a proof over to a machine?

> "The argument raging over AI in mathematics is a microcosm of a larger question facing society"

Naturally, not everyone agrees with this suggestion. And the argument raging over AI's use in mathematics is a microcosm of a larger question facing society: just when is it appropriate to let a machine take over? Tech firms are increasingly promising that AI agents will remove drudgery by taking on mundane tasks from processing invoices to booking holidays. However, when we tried letting them run our day (see page 34), we found that these agents aren't yet fully up to the job.

Relinquishing control by handing your credit cards or your password to an opaque AI creates the same sense of unease as with the four colour proof. Only now, we are no longer colouring in a map, but trying to find its edges as we probe new territory. Does evidence that we can rely on machines await us over the horizon, or merely a digital version of "here be dragons"? ▮

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News

A special visitor
An interstellar object is flying through our solar system **p10**

Heavy cargo
Prehistoric Spanish people moved huge stone by boat **p14**

More cheese please
A step towards an eco-friendly way of making cheese **p16**

Case sensitive
AI's medical advice depends on how you type **p17**

Orcas bearing gifts
Killer whales are presenting dead prey to humans **p19**

ESO/P. DAS ET AL. BACKGROUND STARS (HUBBLE): K. NOLL ET AL.

Space

Dead star exploded twice

This isn't an eye in the sky, but the remains of a white dwarf star that appears to have exploded twice. The two concentric rings around the supernova remnant SNR 0509-67.5 offer the first evidence we have of a double detonation. The two explosions are thought to have happened tens of seconds apart, but due to the high speeds of the ejected material, each ring is separated by huge distances.

Artificial intelligence

Is AI about to change maths forever?

The latest generation of artificial intelligence models is taking on the job of checking mathematical proofs, but some wonder how useful they can really be, finds **Alex Wilkins**

ARTIFICIAL intelligence could be about to transform the way we do mathematics, thanks to automated tools that can help write proofs suddenly showing impressive leaps in capability.

Around 100 of the world's top mathematicians gathered at the University of Cambridge in June for a conference whose theme was based on whether computers might help mathematicians resolve some long-standing problems over how to check that their proofs were correct. This process, known as formalisation, doesn't necessarily have to involve artificial intelligence, and indeed a similar meeting held at Cambridge in 2017 made no mention of AI.

But eight years later, AI has come on in leaps and bounds, most notably with the success of large language models powering tools like ChatGPT. This has attracted new interest to the question of how AI might affect mathematics, from automatically translating human-written proofs into a formal,

"I imagine that some mathematicians will use AI tools very creatively, while some will keep a distance"

computer-checkable language, to constructing proofs themselves.

"It's a little bit overwhelming," says Jeremy Avigad at Carnegie Mellon University in Pennsylvania, who helped organise the meeting. "It's nice; I've been doing this for a long time and it used to be kind of a fringe, niche thing. All of a sudden, I find myself popular."

Two of the talks were put on by Google DeepMind, which last year made headlines when its AI system, AlphaProof, achieved a silver medal score at the International Mathematical Olympiad (IMO), a prestigious competition for young

LUCADP/GETTY IMAGES

AI tools could help solve some complicated maths problems

mathematicians and a long-standing target for AI systems. "If you talk to mathematicians and ask them about the [AlphaProof] IMO results, you would have had different reactions. I think most would say that these are pretty hard high school problems, but maybe some other mathematicians would call them trivial," says Thomas Hubert, a research engineer at DeepMind.

Hubert and his team showed that AlphaProof could go beyond the IMO competition, to aid in formalising a small part of the prime number theorem, an important result in number theory. The mathematics had already been converted to Lean, a programming language, but AlphaProof was able to prove the theorem and then check it was correct. "I wanted to do a demo of how AlphaProof could be used in real life," says Hubert.

Morph Labs, a US-based AI startup, also demonstrated an AI tool called Trinity, which is designed to translate proofs completely automatically, starting from the handwritten mathematical notation and generating a fully formalised and checked proof in Lean. Bhavik Mehta at Imperial College London, who has consulted with Morph Labs, showed an example of Trinity proving a theorem relating to the ABC conjecture, which infamously remains the subject of intense debate about whether it is true or not – something that formalisation could address.

Chain reaction

Though this proof was only a tiny building block of the entire proof needed for the ABC conjecture, and Trinity required a slightly more detailed version of the handwritten proof than the original paper, many people were surprised at how much correct mathematical code was generated by the tool.

"The difference between what Morph did and what had gone before was that they took an entire maths paper, albeit one from 1962 that was only four pages long, a human [then] broke the argument down into small pieces and then a machine just translated the entire thing into Lean," says Kevin Buzzard at Imperial College London. "I'm not sure we've seen anything like that before."

However, it still isn't clear how this will work for other areas of mathematics, says Mehta. "This was essentially the first attempt, and the first attempt worked, maybe it got lucky."

Christian Szegedy at Morph Labs claims that once the tool is fully up and running, it will quickly progress. "Once a feedback loop is established and we don't need the amount of hand-holding that this theorem needed... then it becomes basically a chain reaction and we can do all of mathematics at once," he says.

Tools like these are already at the point that they could be incredibly helpful to mathematicians, says Timothy Gowers at the University of Cambridge. "It will just take some work to create them, and there seem to be a lot of people who are keen to do precisely that, so I think that over the next few – and I really mean few, anything

from one to five – years, there will have been changes to how we do maths that will rival in importance the changes to mathematical practice brought about by email, LaTeX [the standardised maths notation], arXiv [an online paper repository] and Google."

But not all mathematicians agree that the Morph Labs paper was so impressive. Rodrigo Ochigame at Leiden University in the Netherlands cautions that we don't know the full details of the work. "They posted only a single, possibly cherry-picked, output of their system without writing a paper or sharing basic information about their methods. They didn't even say if they tested their system on any other theorems," he says. "When asked by the audience about the amount of compute used by the model, they repeatedly declined to answer, making it difficult to assess the significance of their result."

And scepticism remains about how useful AI tools can be. Most mathematicians still work without the use of automated tools, and it is unclear whether they will change their minds as the tools improve, says Minhyong Kim at the International Centre for Mathematical Sciences in the UK. "Mathematicians are incredibly diverse in their inclinations. I imagine some people will end up using AI tools very effectively and creatively, while some will try to maintain a distance."

"People underestimate the complexity, creativity and subtlety of mathematical research," says Ochigame, which is why so much research is still done using pen, paper and deep thought. "There is a huge gap between high school math competitions, such as the IMO, and cutting-edge research," he says. ▮

Health

Nighttime light exposure linked to heart disease

Helen Thomson

THE more light you are exposed to at night, the higher your risk of heart disease, according to the largest study yet on how night light affects heart health.

Multiple environmental and behavioural cues synchronise our body's circadian rhythms – internal clocks that govern physiological processes. However, modern life can throw off these biological timers, increasing our susceptibility to different conditions.

Light, a major enforcer of circadian rhythms, has long been linked to various health impacts. For instance, shift workers exposed to light at night have a higher risk of heart disease.

Previous studies that used satellite data found associations between people living in bright, urban areas and heart disease, but they only measured outdoor light at night. Daniel Windred at Flinders University in Adelaide, Australia, and his colleagues wanted to know whether an individual's overall light exposure was associated with cardiovascular problems.

They tracked about 89,000 people without cardiovascular disease who wore light sensors for one week between 2013 and 2016. "This is the biggest study of personal light exposure patterns and cardiovascular health to date," says Windred.

The sensors captured any natural or artificial light from their environment, including that emitted from phones. Over eight years, those with the brightest nights had a 23 to 56 per cent higher risk of developing cardiovascular disease than those with dark nights (medRxiv, doi.org/pvc6).

"With the advent of the 24/7 society, disruption of our circadian systems has become common"

An example of a person in the highest light exposure group might be someone who turned on overhead lights for an hour between midnight and 6 am. "This would have placed them in the top 90-100th percentile of night light exposure," says Windred. He adds that the body continues to respond to an artificial light after it has been switched off, and even short exposures can have an effect.

The researchers controlled for factors like sex, age, smoking and shift work. They also showed that the association between light exposure and heart disease risk was independent of sleep duration or efficiency, or a genetic predisposition to heart disease – pointing to night light exposure as the key driver of the results.

Intriguingly, although women typically experience lower rates of heart disease at the same age as men, due to oestrogen's protective effects, the women in the study exposed to bright night light had similar heart risks to the men. Evidence suggests that women experience greater suppression of the hormone melatonin, which drives circadian rhythms, in response to bright light, says Windred. "Their circadian system is more sensitive to bright light compared to men."

Disruption to circadian rhythms can impair glucose tolerance, increasing the risk of type 2 diabetes, which is itself a risk factor for heart disease. This disruption can also affect blood pressure and increase the risk of abnormal heart rhythms due to conflicting signals between the brain and heart.

"The importance of these observations cannot be understated," says Martin Young at the University of Alabama at Birmingham. "With the advent of the 24/7 society, disruption of our circadian systems has become increasingly common. This study highlights the significant health hazards associated with exposure to [light] at the 'wrong' time."

Windred recommends trying to make nights darker, for instance by using dim, warm lighting if you get up during the night. ▮

The body continues to respond to artificial light even once it is off

EDWIN TAN/GETTY IMAGES

Ancient humans

Child's skull could be an ancient-human hybrid

Taylor Mitchell Brown

ISRAEL HERSHKOVITZ

The girl's jaw was distinctly Neanderthal, while the rest of the skull was *Homo sapiens*

A 140,000-YEAR-OLD hominin skull from Israel probably belonged to a hybrid child of Neanderthal and *Homo sapiens* parents. The 5-year-old girl was buried within the earliest known cemetery, possibly reshaping what we know about the first organised burials.

The skull was unearthed from Skhul cave on Mount Carmel in 1929. In total, these early excavations uncovered seven adults, three children and an assortment of bones that belonged to 16 hominins – all later assigned to *H. sapiens*.

The classification of the child's skull, however, has been contested for nearly a century, partly because the jaw looks dissimilar to typical *H. sapiens* mandibles. Original work hypothesised that it belonged to a transitional hominin called *Palaeoanthropus palestinensis*, but later research concluded it most likely belonged to *H. sapiens*.

Anne Dambricourt Malassé at the Institute of Human Paleontology in France and her colleagues have now used CT scanning on the skull and compared it with other known Neanderthal children.

They found the mandible had distinct Neanderthal characteristics, while the rest of the skull was anatomically consistent with *H. sapiens*. They conclude that this combination of features suggests that the child was a hybrid whose parents were different species (*L'Anthropologie*, doi.org/pvmc).

"I have long thought that hybridisations were not viable and I continue to think that they were mostly abortive," says Malassé. "This skeleton reveals that they were nevertheless possible, even though this little girl lived only 5 years."

However, we can't definitively identify the child as a hybrid without extracting its DNA, which researchers haven't been able to do, says John Hawks at the University of Wisconsin-Madison.

The study forces us to call into question the attribution of the earliest grave site to *H. sapiens*, says Malassé. This ritualised behaviour may have come from Neanderthals, *H. sapiens* or interactions between the two. ▮

Space

Interstellar visitor is flying through our solar system

Matthew Sparkes

AN INTERSTELLAR object has been spotted zipping through our solar system, and amateur and professional astronomers around the world are now racing to train their telescopes in its direction, allowing them to refine models of its trajectory and officially confirm that it is a visitor from another star.

The comet – originally called A11pl3Z – is only the third interstellar object we have seen. The asteroid 'Oumuamua was the first, spotted in October 2017, three days after it made its closest approach to Earth. Its unusual acceleration led to controversial suggestions from some quarters, now debunked, that it could be an alien spaceship. A second object, comet Borisov, was seen in 2019, and as it was spotted earlier in its journey through the solar system, we were able to observe it in more detail.

A11pl3Z was first noticed by NASA's Asteroid Terrestrial-impact Last Alert System (ATLAS). Earlier images of the object caught by ATLAS, but not spotted at the time, have since been found in data from 14 June, while amateurs at the Deep Random Survey in Chile and others have gathered new observations. The Minor Planet Center – the official body responsible for observing and reporting on such objects – has now designated it as 3I/ATLAS, indicating both its status as the third interstellar object and its discoverers.

The object is thought to be around 20 kilometres wide and currently travelling around 60 kilometres per second, but it will accelerate as it is drawn in by the sun's gravity. It will reach its closest point to the sun in October, passing within 2 astronomical units – or twice the distance that Earth is from the sun – before swinging away and eventually leaving the solar system.

That will give us limited time to study 3I/ATLAS, but because it has been seen on its way into the solar system, we will at least have more time than with the other interstellar objects. "They really do whip through the solar system at ridiculous speeds," says Mark Norris at the University of Central Lancashire in the UK.

> "Interstellar objects really do whip through the solar system at ridiculous speeds"

"They're really fleeting and you are severely limited in what you can learn about them."

Unfortunately, the chance of sending a mission to intercept the visitor and study it up close is beyond current technology, says Norris. "If we launched it today, the thing's already gone," he says. In years to come, this could change. The European Space Agency (ESA) is planning to send its Comet Interceptor mission into space in 2029, where it will wait to pounce on newly discovered comets or even an interstellar object.

For now, astronomers will have to rely on existing telescopes to examine 3I/ATLAS from afar. "It will be observable roughly until the end of the year, so we have plenty of time to fix the trajectory well enough to then train spectrometers on it," says Richard Moissl at ESA. "Our observers are already trying to find out when is the soonest they can look at it. Everyone is quite excited about this and gearing up." ▮

Technology

Home solar's threat to power grids

Hackers could target connection between solar panels and the power systems they plug into

James Woodford

POWER grids around the world are increasingly under threat from cyberattacks because of the vulnerabilities of home solar installations.

As distributed energy resources like rooftop solar become more prevalent, grids are increasingly reliant on smart inverters, which manage connections to local power networks.

"While these technologies offer many benefits, they also introduce new operational and cybersecurity challenges," says Sid Chau at CSIRO, an Australian government research agency.

Smart inverters convert the direct current produced by solar panels into the alternating current needed to power appliances. They also optimise energy storage and enable monitoring via the internet.

These web connections enable them to pose a threat not just to home solar systems, but also to the wider power-generation network, Chau and his team warn.

They identified multiple ways that smart inverters could be hacked, including exploitation of the security flaws in the physical hardware and software of smart inverters. Malicious actors could trick users into granting excessive permissions for apps connected to the inverter or work with manufacturers to embed malicious code into the hardware (arXiv, doi.org/pvc3).

Chau and his colleagues modelled the threat only in Australia, where around a third of homes have rooftop solar. But the situation is similar for other power grids where private solar systems are becoming more common.

A third of homes in Australia have solar panels on their roofs

While any attack would require careful planning, the researchers found that, if vulnerabilities align, relatively few solar smart inverters would need to be hacked to cause disruption. Once the smart inverter has been compromised, hackers can mount coordinated attacks on the broader power grid, according to the researchers.

Of particular concern are attacks targeting the frequency control of the power grid. In Australia and Europe, the grid frequency needs to stay close to 50 hertz. While there are mechanisms to protect the grid, any deviation from this can lead to cascading power-system failures.

Compounding the risk, many inverters have long lifespans, of 15 years or more, meaning their cybersecurity defences can easily become outdated.

Chau says authorities need to have better oversight of private inverters so they can quickly override them if suspicious activity is detected. He also says there needs to be long-term support for owners and compliance checking to ensure smart inverters meet cybersecurity and maintenance requirements.

Ernest Foo at Griffith University in Brisbane, Australia, says critical infrastructure is vulnerable to cyberattacks because of its legacy design and components. "With the help of a bigger uptake of distributed photovoltaics and perhaps with the use of machine learning and AI, cyberattack is more likely than previously thought," he says. ▮

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Origins of life

Protocells self-assemble on micrometeorites

MEMBRANE-bound structures similar to those that enclose living cells have been shown to self-assemble on micrometeorites, offering a tantalising hint that dust strewn across planets could play a role in the development of life.

"If we can show that protocells are forming on micrometeorites on Earth, then it's evident that this could happen on other habitable planets," says Irep Gözen at GOMOD, a research and education company in Sweden.

Some fatty molecules called lipids can spontaneously form membrane-bound spheres, which are sometimes called protocells as they are thought to resemble the precursors to living cells. While this can happen in solution, Gözen has been studying how some surfaces trigger protocell formation where it wouldn't otherwise happen.

Surfaces have intrinsic energy that can power this kind of transformation because the atoms on their exposed sides don't have a complete set of bonds, she says. "The moment you create a surface, it will have this excess energy that it wants to get rid of."

After recently studying a Martian meteorite, Gözen realised that the rough, grainy surfaces of meteorites might be favourable for protocell formation. So she and her colleagues placed three kinds of micrometeorites in dishes containing suspensions of various kinds of lipids.

"If we can show this happens on Earth, then it's evident this could happen on other habitable planets"

They left the samples overnight and then examined them under a microscope, finding that protocells had indeed formed. They were particularly prolific in the samples that contained the same lipids as the membranes of simple cells called archaea (bioRxiv, doi.org/pvc5).

"I think it's exciting that micrometeorites have sufficient surface energy to drive the [protocell] formation mechanism," says Anna Wang at the University of New South Wales Sydney in Australia. "The physics was not a given." ▮

Michael Le Page

Quantum computing

Quantum-enhanced supercomputers

Using a supercomputer to check a quantum computer's calculations opens the door to error-free applications in chemistry, finds **Karmela Padavic-Callaghan**

A QUANTUM computer and conventional supercomputer that work together could become an invaluable tool for understanding chemicals. A collaboration between IBM and the Japanese scientific institute RIKEN has now created one path to getting there.

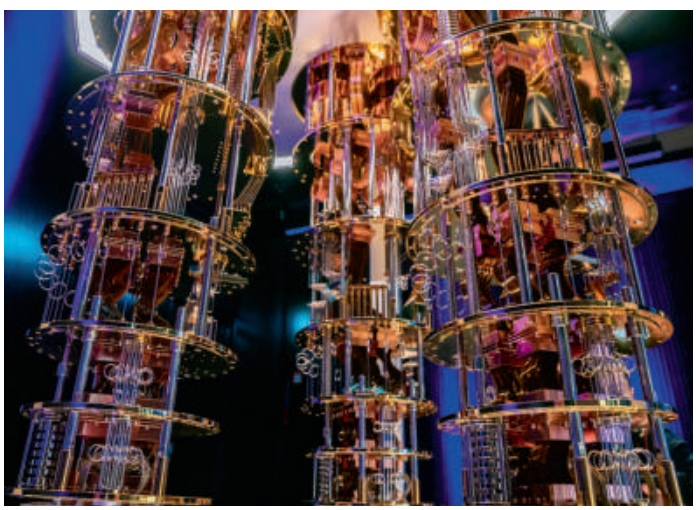
Predicting what a molecule will do within a reaction – for instance, as part of a medical treatment – often hinges on understanding its electrons' quantum states. Quantum computers could accelerate determining these states, but in their current form, they are still prone to errors. Conventional supercomputers can catch those mistakes.

In a joint statement to *New Scientist*, Seiji Yunoki and Mitsuhisa Sato at RIKEN said quantum computers can push traditional computers to new capabilities. They and their colleagues have used IBM's Heron quantum computer and RIKEN's Fugaku supercomputer to model molecular nitrogen, as well as two different molecules made from iron and sulphur.

Quantum computers are currently still prone to errors in calculations

The researchers used up to 77 quantum bits, or qubits, and an algorithm called SQD to divide the computation of molecules' quantum states between the machines. The quantum computer made calculations, while the supercomputer checked for and corrected errors. For instance, if Heron produced a mathematical function describing more electrons than contained in the molecule at hand, Fugaku would discard that part of the solution and have Heron update and repeat the calculation (*Science Advances*, doi.org/pvcx).

This hybrid method doesn't yet surpass the best-case scenario of what a supercomputer could do alone, but it is competitive with some standard approaches, says Jay Gambetta at IBM, who wasn't involved with the experiment. "It's [now] just about comparing computational tools."



THOMAS NIEDERMUELLER/GETTY IMAGES

In the near term, this is the "secret sauce" for getting error-prone quantum computers to do chemistry, says Kenneth Merz at the Cleveland Clinic in Ohio. Using a different IBM quantum computer yoked to a classical computer, his team developed a variation of the SQD algorithm that can model molecules in solutions, which is a more realistic representation than previous models (*The Journal of Physical Chemistry B*, doi.org/pvcz).

The surprising benefits of quantum randomness

Quantum computers can produce randomness much more easily than previously thought, a discovery that shows we still have much to learn about how the strange realm of quantum physics intersects with computation.

Randomness is a key component of many computational tasks. For quantum computers, arranging their quantum bits, or qubits, in random configurations to produce results is one way that researchers have attempted to demonstrate quantum advantage, where quantum computers can do tasks that are effectively impossible for classical machines.

Setting up these random configurations essentially means shuffling the qubits and the way they link together multiple times, similar to the way you would shuffle a deck of cards. But just as a larger deck of cards is more unwieldy to shuffle than a smaller one, this process was thought to take much longer as you added more qubits to your system. Because more shuffling increases the chances of ruining the qubits' delicate quantum state, this meant that many useful applications that relied on randomness were thought to be limited to small quantum computers.

Now, Thomas Schuster at the California Institute of Technology and his colleagues have found that these random sequences can be produced with fewer shuffles than we thought. To show this, the team imagined dividing a collection of qubits into smaller blocks, and then mathematically proved that these blocks could each produce a random sequence. Then, they proved that these smaller qubit blocks could be "glued" together, creating a well-shuffled version of the original set of qubits in an unexpected way (*Science*, doi.org/pvc2).

"It's just very surprising, because you can show that similar stuff does not hold for random number generators in classical systems," says Schuster. For example, shuffling a deck of cards in blocks would be very noticeable, because cards in the top block would always stay near the top. This isn't true in the quantum case, because the quantum shuffling creates a random superposition of all possible reshuffles. "It's really a kind of new and intrinsically quantum phenomenon," he says.

"This kind of random quantum behaviour we all expected to be extremely hard to generate, and here the authors showed that you could do this essentially as efficiently as you can imagine," says Pieter Claeys at the Max Planck Institute for the Physics of Complex Systems in Germany. "It was a very surprising finding."

Alex Wilkins

In Merz's view, further optimisations of SQD could help the combination of quantum and conventional computing gain tangible advantages over the latter alone within the next year.

Hybrid computing

"The combination of quantum and supercomputing is not only worthwhile – it's inevitable," says Sam Stanwyck at computing firm Nvidia. A realistic use of quantum computing is one where quantum processors are integrated with powerful classical processors in a supercomputer centre, he says. Nvidia has already developed a software platform that aims to support such hybrid approaches.

Aseem Datar at Microsoft says his firm also has its sights set on the "tremendous potential in the combination of quantum computing, supercomputing and AI to accelerate and transform chemistry and material science".

But while quantum computing industry stakeholders champion the idea, many challenges remain. Markus Reiher at ETH Zurich in Switzerland says the results from the RIKEN experiment are encouraging, but it isn't yet clear whether this approach will become the preferred way to conduct quantum chemistry computations. For one thing, the accuracy of the quantum-supercomputer pair's final answer remains uncertain. For another, there are already well-established conventional methods for performing such computations – and they work very well.

The promise of incorporating a quantum computer into the computation process is that it could help model bigger molecules or work more quickly. But Reiher says that scaling up the new approach may be difficult. ▮

Archaeology

Ancient Egyptian's genome hints at links with Mesopotamia

Michael Marshall

FOR the first time, the complete genome of a person from ancient Egypt has been sequenced. The man, who possibly worked as a potter, lived over 4500 years ago.

The ancient Egyptian inherited about a fifth of his DNA from ancestors living in the Fertile Crescent in the Middle East, more than 1000 kilometres east of Egypt. This suggests that the societies of Egypt and Mesopotamia were connected.

The body was excavated in the early 1900s from Nuwayrat, a necropolis near Beni Hasan in Egypt. It was found in a pottery vessel, which had been placed in a rock-cut tomb. Today, the remains are kept at the World Museum in Liverpool, UK.

"We could actually directly radiocarbon date the remains of this individual," says Adeline Morez Jacobs at Liverpool John Moores University. He died sometime between 2855 and 2570 BC (*Nature*, doi.org/pt7n). That means he lived fairly early in the history of ancient Egypt, which lasted from around 3150 to 30 BC.

The skeleton and DNA both showed the individual was male. Based on the man's arthritis and other signs, he was estimated to be between 44 and 64 years old. "He's probably in his 60s at the time of death, which is incredibly old for that time period," says Joel Irish, also at Liverpool John Moores University.

20%

Percentage of the man's DNA that came from the Fertile Crescent

The social position of the man is unclear. "He was in what would have been an upper-class burial," says Irish. But his skeleton shows that he had a hard, physical life. Based on the specific damage, he spent a lot of time looking down, leaning forward and holding his arms out in front of him, says Irish. He also sat for long periods on hard surfaces. Based on preserved images of different Egyptian occupations, the researchers think he was a potter.

Using samples from the roots of his teeth, the team was able to sequence the man's entire genome. Previously it had been possible to obtain only partial genomes from three ancient Egyptians, who lived over 1000 years more recently.

"We have so little genetic sequencing from ancient Egypt," says Shirly Ben-Dor Evian at the University of Haifa in Israel. This is because the region's warm climate degrades DNA quickly.

About 80 per cent of the man's genetic ancestry was North African, as might be expected. But the remaining 20 per cent matched people from the eastern Fertile Crescent, a geographical area that encompasses present-day Iraq, western Iran and parts of Syria and Turkey.

There are several possible explanations, says Ben-Dor Evian. "I'm thinking that explorers were always a thing," she says. Also, long after farming became commonplace, "there were always populations that continued to be nomadic or semi-nomadic", she says. Those peoples may have carried DNA between the two regions.

Archaeologists have already found links between ancient Egypt and Mesopotamia. "There was quite a bit of cultural connections with Mesopotamia based on sharing artistic motifs," says Irish, and goods like lapis lazuli were traded.

There could even be implications for the origin of writing. "The first writing systems emerged almost contemporaneously in the two regions," says Morez Jacobs: cuneiform in Mesopotamia and Egyptian hieroglyphics just 300 years later.

"Was it a local invention of writing in both places, [or] were they, in some way, affecting each other?" asks Ben-Dor Evian. ▮

Damage to the skeleton suggests the ancient Egyptian man was a potter

DEAGOSTINI/GETTY IMAGES

Archaeology

Prehistoric Spanish people moved 2-tonne stone by boat

Taylor Mitchell Brown

A 2-TONNE megalith in southern Spain was transported to its present location by a hitherto-unknown group of ancient seafarers over 5300 years ago.

The Matarrubilla stone is a solid slab of gypsum about 1.7 metres long by 1.2 m wide, sitting within a tomb-like structure at the Copper Age site of Valencina, near Seville.

It is located within a circular chamber called a tholos, with just enough room to stand around it. Given its unique composition and size, it is thought that the stone was used in rituals, but its provenance has been a mystery until now.

Luis Cáceres Puro at the University of Huelva in Spain and his colleagues performed chemical analysis on the slab and optically stimulated luminescence dating – which approximates the last time light struck sediments – on the soil beneath it to better determine its age and site of origin.

The results suggest it was dragged to its current location between 4544 and 3277 BC, which is hundreds of years – possibly even 1000 years – earlier than previously thought. The new dates also suggest the rock was moved to Valencina long before the structure was built around it (*Journal of Archaeological Science*, doi.org/pvck).

The stone's composition most closely matches a quarry 55 kilometres away on the other side of the Guadalquivir river. At the time, there was a wide estuary between the two sites, suggesting the stone was transported by boat.

This is the first evidence of a megalithic stone being moved by boat in the Iberian peninsula, but large stones at other sites in Europe, such as Stonehenge in the UK and Carnac in France, are also thought to have been transported this way.

L. GARCÍA SANJUÁN

This huge stone sits inside a tomb-like structure

"The 4th millennium BC saw rapid evolution in coastal navigation," says team member Leonardo García Sanjuán at the University of Seville. "The Matarrubilla stone basin is a good piece of indirect evidence, which, in our opinion, proves that these people had advanced raft, canoe or sailing-boat technology."

Archaeological discoveries from other sites show that communities in the Mediterranean were already building sophisticated, seaworthy boats, he adds.

4544 BC

Earliest time the megalith was moved to its current location

"The crossing of the formerly existing sea with such a huge stone proves once again the technical savoir-faire of the Matarrubilla builders," says Ramón Fabregas Valcarce at the University of Santiago de Compostela in Spain.

Valencina is one of the largest prehistoric sites in Europe, covering more than 460 hectares. Among the site's rarer artefacts are materials imported from far-flung regions, including amber, flint, cinnabar pigment, ivory and ostrich egg.

"[Valencina] contains megalithic monuments, massive ditches, extensive burial records and refined material culture that reveals connections across Iberia, North Africa and the Mediterranean," says Cáceres Puro.

Prior work in the area has detailed the site's historical significance, including a centuries-long period from 2900 to 2650 BC when it was largely ruled by women.

"The current study adds intriguing further detail for one of Valencina's major monuments," says Alasdair Whittle at Cardiff University, UK. ▮

Space

Habitats on Mars could be built from algae

Karmela Padavic-Callaghan

WHAT would you bring to Mars if you were setting up home?

Robin Wordsworth at Harvard University has a list: algae, a small bioreactor, a 3D printer and several flask-like containers made from bioplastic built with plant material. Such bioplastics, produced by algae grown in reactors on the planet, could be used to build Martian homes.

He says he would grow algae in the containers, use the bioreactor to turn that algae into more bioplastic, then 3D-print more containers to grow more algae, and so on.

"The concept is that you use a material to make your habitat, which can be constructed from the biology itself. You can create a self-sustaining system," he says. Wordsworth and his colleagues have now demonstrated the first part of this cycle.

They grew the green algae *Dunaliella tertiolecta* in containers made from 1-millimetre-thick pieces of a bioplastic called PLA. To match Martian conditions, they placed each container in a chamber where the pressure was about 0.6 per cent of atmospheric pressure on Earth and the air contained more than 98 per cent carbon dioxide. Over 10 days, they found that the algae grew and photosynthesised at rates comparable to those in more Earth-like conditions (*Science Advances*, doi.org/g9r5r6).

The idea of 3D-printing bioplastic habitats is about a decade old, but the new experiment shows that these really could sustain life, says Amor Menezes at the University of Florida. "This is tremendously exciting. A journey to Mars, and a stay on Mars, will be roughly a couple of years long, so we can't take everything with us," he says. "This shows that bioplastics can potentially support life in Mars-like conditions, and maybe that a lot of useful objects during a Martian stay could be bioplastic." ▮

Health

Microbes linked to colorectal cancer

"Harmless" archaea found in our gut may not be as benign as we thought

Chris Simms

MYSTERIOUS microorganisms called archaea seem to play a role in colorectal cancer. This supports the idea that such microbes, which were thought to be harmless, could actually be involved in disease.

There are three domains of life. The first comprises single-celled bacteria. The second is made up of organisms known as eukaryotes that are often multicellular, including all animals and plants. These have larger cells packed with internal structures, including a nucleus stuffed with DNA.

Archaea make up the third. These are single-celled organisms that were originally thought to be bacteria because they lack a nucleus, but were found to share some similarities with eukaryotes.

Although the trillions of bacteria and viruses lurking within our gut have been linked to many conditions, including cancer and diabetes, the archaea that live there aren't normally examined for such associations.

"Most scientists who are working on the human microbiome overlook archaea," says Roxy Mohammadzadeh at the Medical University of Graz in Austria. Nonetheless, high numbers of archaea have been seen to occur alongside conditions including colorectal cancer.

"The direct involvement of archaea in human disease has remained poorly understood"

To better understand these associations, Mohammadzadeh and her colleagues searched for any gut archaeal signatures of disease in 19 clinical studies covering more than 1800 people.

They found that associations between archaea and a range of medical conditions are common but variable. However, they did discover a consistent increase of the archaeon *Methanobrevibacter smithii* in people with colorectal cancer. This organism plays a big role in our digestion by consuming products of bacterial fermentation, such as hydrogen and carbon dioxide, and releasing methane.

The team found, via modelling and by culturing the microbes, that *M. smithii* interacted with bacteria including *Bacteroides fragilis*, *Escherichia coli* and *Fusobacterium nucleatum* (bioRxiv, doi.org/pvcj).

Those three species have been linked to colorectal cancer before, but it was the relationship with *F. nucleatum* that seemed most notable. In the presence of *M. smithii*, *F. nucleatum* produced much more of a compound called succinate, a critical metabolic signalling molecule. However, in cancer, succinate is known to enhance tumour invasiveness and its potential to spread.

"It's the first mechanistic evidence showing the role of archaea on human disease and specifically colorectal cancer," says Mohammadzadeh.

This study supports earlier work associating *M. smithii* with colorectal cancer, says Gianmarco Piccinno at the University of Trento in Italy. But given that most of the evidence so far is only correlational, he says further research is required to determine any cancer-causing mechanisms and why people with colorectal cancer have more of this microbe.

"While archaea have been recognised as components of the human microbiome, their direct involvement in disease has remained poorly understood," says Sunny Wong at Nanyang Technological University in Singapore, who has also recently reported links between archaea and colorectal cancer. "Although existing in much smaller numbers than bacteria in the gut, they are metabolically active and often consume hydrogen, produce methane and do interact with bacteria, as well as the host." ▮

Botany

The tree that turns carbon dioxide into stone

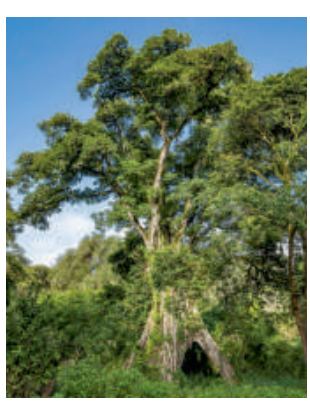
SOME fig trees can convert carbon dioxide into stone, ensuring that the carbon remains in the soil long after the tree has died. This means that fig trees planted for forestry or their fruit could offer additional climate benefits.

All trees take up CO_2 from the air, and most of that carbon typically ends up as structural molecules used to build the plant. Some trees, however, convert CO_2 into a crystal compound called calcium oxalate, which bacteria in the tree and the soil can then convert to calcium carbonate, the main component of stones like limestone and chalk.

Carbon in mineral form can stay within soil for much longer than it can in the tree's organic matter. Trees known to store carbon in this way include the iroko tree (*Milicia excelsa*), which grows in tropical Africa and is used for timber, but doesn't produce food.

Now, Mike Rowley at the University of Zurich in Switzerland and his colleagues have found that three species of fig tree native to Samburu County in Kenya can also make calcium carbonate from CO_2.

"A large part of the trees becomes calcium carbonate above ground," says Rowley. "We [also] see entire root structures that have pretty much turned to calcium carbonate in the soil where it shouldn't be, in high concentrations."



EMIS/ALAMY

Fig trees may offer benefits beyond just their fruit

The team first identified the fig tree species that produce calcium carbonate by squirting weak hydrochloric acid onto the trees and looking for bubbles – a sign of CO_2 being released from calcium carbonate. Then, they measured how far away they could detect calcium carbonate in the surrounding soil and analysed samples of the trees to see where in their trunks it was being produced.

"What was really a surprise, and I'm still kind of reeling from, is that the [calcium carbonate] had really gone far deeper into the wood structures than I expected," says Rowley, who was set to present the work at the Goldschmidt Conference in Prague, the Czech Republic, this week. ▮

Alex Wilkins

Health

One drug could fight all flu strains

A treatment containing an antiviral drug could offer more protection than current flu vaccines

Carissa Wong

A SINGLE dose of a long-lasting antiviral drug has shown promise in protecting against all flu strains, raising hopes that it could help those who are most vulnerable.

Each year, scientists update flu vaccines to match the strains of influenza virus they expect to circulate most widely. These vaccines prompt the immune system to produce antibodies that stop the virus entering your cells.

Scientists are working towards a universal flu vaccine that would protect against all strains that infect people, but it would still have limitations.

"Even if someone came up with the first [approved] universal flu vaccine, it is never going to protect everyone, because people have various degrees of immune response to vaccines," says Jeffrey Stein, CEO at biotech company Cidara. For instance, vaccines are generally less effective in older people or those with suppressed immune systems.

To address this, Stein and his colleagues developed a treatment called CD388, which contains zanamivir, an antiviral drug that is approved for treating infections caused by all flu strains that infect people. Zanamivir is usually cleared from the body within hours, but the team chemically modified it to linger for months in the body, where it can rapidly destroy invading flu viruses. "It doesn't engage the immune system," says Stein.

To put it to the test, the team recruited 5000 people, aged 16 to 64, from the US and the UK at the start of the 2024 flu season. None of the participants was at high risk of flu-related complications or had yet received a flu vaccine that year. The team split the participants into four roughly equal groups. Three received a single injection of CD388 at either a low, medium or high dosage, while the remaining participants took a placebo.

Every year flu vaccines are updated to match the most prevalent strains

CYNTHIA LEE/ALAMY

About six months later, the researchers looked at how many participants had symptomatic flu infections over the entire flu season – defined by the presence of flu virus DNA in nasal swabs, plus flu-like symptoms.

While 33 people in the placebo group had symptomatic flu, only eight people who took a high dose of CD388 did – about a 76 per cent reduction in risk. Those in the medium- and low-dose groups saw their risk of symptomatic infection cut by 61 per cent and 58 per cent, respectively. Similar side effects, such as tenderness at the injection site, occurred across the treatment and placebo groups.

The findings, shared by Cidara at a briefing, suggest CD388 could be a simpler way to protect people than vaccines. "[Unlike vaccines, it] would not need to be matched to circulating strains," says Penny Ward at King's College London. Based on prior data on zanamivir, flu strains are also unlikely to evolve resistance to it, she says.

The approach should work well in people known to respond poorly to vaccination, as it doesn't rely on the host immune response, says Ward. Cidara's chief medical officer, Nicole Davarpanah, says a trial is planned for people aged 12 and over who are immunocompromised. ▮

Environment

A step towards an eco-friendly way of making cheese

IF YOU love cheese but feel guilty about its environmental impact, there is hope on the horizon. The milk protein that is most important for producing cheese and yoghurt has been made in bacteria for the first time, which could allow these products to be made directly from plants without any cows involved.

"It will significantly reduce the carbon footprint," says Suvasini Balasubramanian at the Technical University of Denmark.

Dairy milk is a complex mix of many chemicals, but for cheese manufacture, the most important component is the globules, or micelles, made of proteins called caseins wrapped around calcium compounds.

After casein proteins are first produced in mammary gland cells, most have phosphate groups added to them, a process called phosphorylation. These phosphate groups interact directly with calcium and are essential for the formation of micelles.

24kg

How much carbon dioxide is emitted making a kilogram of normal cheese

While it is simple to get bacteria to make unmodified casein proteins, achieving phosphorylation has proved tricky. But Balasubramanian and her team have now succeeded in producing one kind of phosphorylated casein in *E. coli* bacteria by using bacterial enzymes (*Trends in Biotechnology*, doi.org/pt8w). This casein does have a few more added phosphates than normal, but Balasubramanian points out that the phosphorylation of casein can vary from one breed of cattle to another.

The researchers are now scaling up the process so they can try making cheese and other dairy products from the protein.

Producing a kilogram of cheese currently emits around 24 kilograms of carbon dioxide or equivalents, compared with 100 kilograms for beef but well under 2 kilograms for most plant-based foods. The hope is that producing products such as casein using microbes will dramatically reduce emissions and other environmental impacts. ▮

Michael Le Page

Artificial intelligence

Typos and slang spur AI to discourage seeking medical care

Jeremy Hsu

SHOULD you see a doctor about your sore throat? AI's advice may depend on how carefully you typed your question.

Abinitha Gourabathina at the Massachusetts Institute of Technology and her colleagues used AI to help create thousands of patient notes in different formats and styles. For example, some included typos to mimic patients with limited English. Others used uncertain language in the style of writers with health anxiety, colourful expressions that lent a dramatic tone or gender-neutral pronouns.

The researchers then fed the notes to four large language models (LLMs) commonly used to power chatbots and told the AI to answer questions about whether the patient should manage their condition at home or visit a clinic, and whether they should receive certain lab tests. These AI models included OpenAI's GPT-4, Meta's Llama-3-70b and Llama-3-8b, and the Palmyra-Med model developed for the healthcare industry by the AI company Writer.

The various text changes made all the AI models between 7 and 9 per cent more likely to recommend patients stay at home. The models were also more likely to recommend that female patients remain at home, and follow-up research showed they were more likely than human clinicians to change their advice for treatments because of gender and language style in the messages (*FAccT '25: Proceedings of the 2025 ACM Conference on Fairness, Accountability, and Transparency*, doi.org/g9q6gv).

OpenAI and Meta didn't respond to a request for comment. Writer doesn't "recommend or support" using LLMs – including the company's Palmyra-Med – for clinical decisions or health advice "without a human in the loop", says Zayed Yasin at Writer. ▮

Climate change

Antarctic sea ice loss is more damaging than we thought

James Woodford

BRENT STEPHENSON/NATURE PICTURE LIBRARY/ALAMY

Shrinking sea ice means warmer ocean temperatures

THE collapsing sea ice around the Antarctic continent has led to a doubling in the number of icebergs calving from ice sheets and a surge in sea temperatures, and the impacts are growing more severe as heat accumulates in the Southern Ocean.

Sea ice extent at both poles has decreased precipitously over the past decade. In 2023, the area of Antarctic winter sea ice was a record 1.55 million square kilometres below the expected average extent.

This equates to the disappearance of an area of ice nearly 6.5 times the size of the UK. Ice extent in 2024 was nearly as low, and 2025 is tracking towards a similarly grim level.

Edward Doddridge at the University of Tasmania, Australia, and his colleagues set out to understand the implications of a long-term, drastically reduced protective buffer of sea ice in Antarctica.

The team found that in summers with low sea ice since 2016, the loss of sea ice led to a 0.3°C rise in the average temperature in the Southern Ocean between the latitudes of 65° and 80° south (*PNAS Nexus*, doi.org/pt6n).

More worryingly, the extra heat from a single low-sea-ice year didn't dissipate by the following year. In fact, it kept the ocean warmer for at least the following three years,

"When we have an extreme low-sea-ice year, there's an impact the Antarctic will feel for many years"

making any temperature rise far more serious than expected, says Doddridge.

"We have known for a while that losing sea ice in the summer should warm the ocean, essentially because the sea ice and the snow that sit on top of it are really reflective," says Doddridge.

"The fact that the ocean memory of the warming lasts for three whole years gives the opportunity for the warming impact in the Southern Ocean to compound. Now it's just building and building and building."

Another consequence of such a severe decline in sea ice is that it may lead to a faster loss of the inland ice sheets. When the ocean surface is frozen, it dampens down the Southern Ocean swells, preventing them from striking the edges of the ice sheets that overlay the Antarctic continent. Once the protective skirt of sea ice is gone, the ice sheets on the coastal margin begin to break up more readily.

The team found that for every 100,000-square-kilometre reduction in sea ice, there were an additional six icebergs greater than 1 square kilometre in size breaking away. "In low-sea-ice years, we saw twice as many icebergs," says Doddridge.

The loss of sea ice will also severely affect the species that depend on being able to haul themselves out of the ocean onto a solid platform for their survival. The study predicts that species such as emperor penguins (*Aptenodytes forsteri*) and crabeater seals (*Lobodon carcinophagus*) may be particularly badly affected.

Antarctic science is also made more challenging as sea ice enables ships to safely resupply research stations.

Nerilie Abram at the Australian National University says there are "very few winners in this analysis of how the loss of sea ice will affect the environment down there".

"When we have an extreme low-sea-ice year, there's an impact that the Antarctic system will keep feeling for many years. It's not just a one-off event," says Abram. ▮

Health

Gut linked to PCOS fertility issues

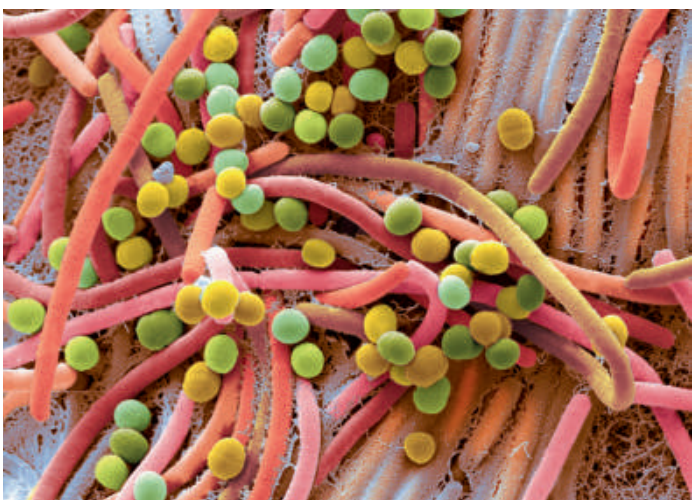
An altered gut microbiome may explain why those with polycystic ovary syndrome experience a higher risk of miscarriage, finds **Grace Wade**

WOMEN with polycystic ovary syndrome (PCOS) have lower levels of a gut microbe, which appears to raise the risk of pregnancy complications.

PCOS is the most common hormonal condition in women of reproductive age and is a leading cause of infertility. Yet relatively little is understood about what causes it or how to best treat it. For instance, it isn't clear why those with PCOS who are able to get pregnant have a higher risk of complications like miscarriage, preterm birth and gestational diabetes.

Aixia Liu at Zhejiang University in China and her colleagues monitored pregnancy outcomes in 220 women across 44 cities in China, half of whom had PCOS. All of them were under 35 years old and provided blood, stool and tissues samples of their endometrium, or the inner lining of the uterus.

Despite similar pregnancy rates, those with PCOS were nearly twice as likely to experience a pregnancy complication, such as miscarriage, preterm birth, gestational diabetes or a child with low birth weight. The researchers also found that those with PCOS had about half the amount of a gut bacterium called *Parabacteroides merdae* than those without the condition and that this was associated with pregnancy outcomes.



STEVE GSCHMEISSNER/SCIENCE PHOTO LIBRARY

Levels of certain gut microbes could be linked with pregnancy outcomes

"It is nice to have a potential target to treat because we don't really have specific treatments for PCOS"

P. merdae helps convert certain nutrients, such as the amino acid isoleucine, into beneficial compounds called short-chain fatty acids that play an important role in reproductive health. This probably explain why participants with PCOS had, on average, about 39 per cent more isoleucine and 10 per cent lower levels of short-chain fatty acids in blood samples than those without it. They also had higher levels of isoleucine in endometrial tissues.

When the researchers cultured the participants' endometrial cells and exposed them to isoleucine in a dish, they saw an increase in markers of cellular senescence, where cells become so worn or damaged that they cease to function.

The isoleucine also hindered the process endometrial cells undergo in preparation for, and during, pregnancy.

"These findings indicate ageing-like changes in the uterus," said Liu in a press release from an annual meeting of the European Society of Human Reproduction and Embryology, where she presented these findings. "Our data suggest that high isoleucine levels and the loss of *P. merdae* may impair endometrial health, even in women under 35."

While this suggests that changes to the gut microbiome may contribute to fertility issues in PCOS, Andrea Dunaif at the Icahn School of Medicine at Mount Sinai in New York state is sceptical. Her own research suggests that reproductive ageing in PCOS is delayed, rather than accelerated. "Their reproductive abnormalities tend to improve in their 30s," says Dunaif. "That makes me sceptical about how significant the endometrial findings are, and if they are really what is responsible for these alterations and pregnancy outcomes."

Still, these findings could lead to improved fertility treatments for PCOS. "The microbiome is something [where] you could intervene with different probiotics to alter the [bacteria]," says Dunaif. "So that is nice to have a potential target to treat because we don't really have any specific treatments for PCOS." ▮

We may know how PCOS is passed on

POLYCYSTIC ovary syndrome (PCOS) often runs in families, but it isn't clear how it is inherited.

Studies in mice suggest changes in epigenetic marks, the chemical tags that turn genes on and off without altering DNA sequences, may play a role. It is thought most such marks are erased when eggs form, but some could remain.

To see if this occurs in connection with PCOS in humans, Qianshu Zhu at Chongqing Medical University in China and his colleagues analysed epigenetic marks in eggs and 3-day-old embryos donated by 133 people with PCOS and 95 people without.

This revealed a link between PCOS and changes in three types of epigenetic marks in the eggs and embryos. Two of these marks turn genes off by making DNA coil more tightly around proteins called histones, which help package it within cells. This makes the genetic code in DNA less accessible to molecules that transcribe it into RNA, a key step in making proteins. The third mark activates genes by loosening DNA coils.

Together, these changes altered the metabolism of eggs and embryos, suggesting they may raise the risk of PCOS in offspring.

Zhu presented the results at the annual meeting of the European Society of Human Reproduction and Embryology. Carissa Wong

Animal behaviour

Orcas are bringing humans gifts – hinting they have theory of mind

Marina Wang

KILLER whales have been seen appearing to gift dead prey to humans, which may be a sign that they engage in altruism and can recognise sentience in other species.

Jared Towers at marine research firm Bay Cetology was filming a pod of orcas (*Orcinus orca*) as they snacked on seabirds in Alert Bay, Canada, when he made the discovery. Two of the whales, Akela and Quiver, approached Towers with birds clutched between their jaws. Akela, a young female, released the dead bird in front of Towers and lingered for a moment, as if to watch what he would do. Quiver, Akela's little brother, did the same, dropping the bird and waiting.

> "They're taking something they do amongst themselves and spreading that goodwill to others"

Towers watched as the whales then grabbed the prey again and swam away. "I remember thinking, did that just happen?" he says.

This event in 2015 and another in 2018, in which a young female orca presented Towers with a harbour seal pup, inspired him to document cases of killer whales attempting to share prey with humans.

He interviewed others with similar experiences, identifying another 32 cases from between 2004 and 2024 (*Journal of Comparative Psychology*, doi.org/g9rt36). These include a young male orca in New Zealand named Funky Monkey repeatedly approaching a researcher with a long-tailed stingray draped over its head, and a killer whale in Norway seemingly gifting jellyfish to a diver.

In all, 18 different prey species were offered, including blubber from a grey whale, seals, jellyfish, birds, an otter, rays, a starfish and a turtle – plus a strand of seaweed.

This behaviour has previously been seen within orca pods. "They live in very close-knit, complex, social societies and share prey throughout their entire lives," says Towers.

JARED TOWERS

Orcas playing with their prey before gifting it to humans

But it doesn't seem to stop there. "They're taking something they do amongst themselves and spreading that goodwill to another species," says Lori Morino at New York University.

Towers says this demonstrates that killer whales are capable of generalised altruism, or kindness. It also shows that orcas can recognise sentience in others and are curious and bold enough to experiment across species, he says. This generalised altruism makes sense in social societies where members benefit from cooperation.

Killer whales are also some of the few marine predators that occasionally find themselves with excess prey. Sometimes, a pod will kill a larger whale than they can finish, for example. "You can just leave it, you can play with it or you can use it to explore relationships in your environment," says Towers.

For killer whales – many of which are generalist predators – curious or exploratory behaviour is an advantage. "Curiosity is one of the things that reduces uncertainty," says Towers. "They're actively learning about us by testing the waters."

He also says the behaviour demonstrates that orcas have theory of mind, the ability to understand others have distinct mental states that differ from one's own. This has been seen in some birds, non-human apes and other marine animals such as dolphins. ▮

Archaeology

DNA reveals secret of Roman Empire's favourite sauce

FERMENTED fish sauce, or garum, was an incredibly popular condiment throughout the Roman Empire. For the first time, ancient DNA – scraped from vats used to produce the sauce – has revealed exactly which fish species went into the culinary staple.

Roman fish sauce was prized for its salty and umami flavours – although the philosopher Seneca famously described one version as "the overpriced guts of rotten fish".

ALEXANDER MYCHKO/ALAMY

A modern-day version of garum – a staple dish in ancient Rome

It came in several forms, including a liquid sauce called garum or liquamen, as well as a solid paste known as allec. To prepare the condiment, workers at fish-salting plants crushed and fermented fish, a process that can make visual identification of the species difficult.

Paula Campos at the University of Porto in Portugal and her colleagues ran DNA sequencing tests on bony samples from roughly the 3rd century AD, extracted from a Roman fish-salting plant in north-west Spain. They were able to compare multiple overlapping DNA sequences and match them to a full fish genome.

They identified the fish remains as European sardines – a finding that aligns with previous visual identification of sardine remains in other Roman-era fish-salting plants (*Antiquity*, doi.org/pt6p). Other garum production sites have also contained remnants of additional fish species such as herring, whiting, mackerel and anchovy.

Campos and her colleagues next plan to analyse other fish species from additional Roman-era garum production sites. "We are expanding the sampling locations to see if the results are consistent across the entire Roman Empire," she says. ▮

Jeremy Hsu

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Views

The columnist
Chanda Prescod-Weinstein considers cosmic distances p22

Aperture
An intimate shot of an octopus and her developing eggs p24

Culture
Controversial book warns of plummeting global population p26

Culture columnist
Bethan Ackerley is sad to see *Foundation* lose the plot p28

Letters
We do have free will, but we are squandering it p29

Comment

A test too far

A plan to genetically screen newborns for a huge range of rare diseases is medically and ethically problematic, says **Suzanne O'Sullivan**

RARE diseases are often hard to spot. They can evade detection until irreversible organ damage or disability has already set in. Last month, in the hope of preventing just this type of harm, the UK's health secretary, Wes Streeting, announced a 10-year plan to make genetic testing for hundreds of rare conditions part of standard newborn screening in England. The world is likely to follow, with numerous feasibility programmes already under way, including in the US and Australia. Streeting's plan is to "leapfrog" disease before it becomes symptomatic. But how scientifically sound is this, exactly?

The genome is a list of letters that feels as if it could be read like a book, but it is a book in a language so new that only a small number of words have been deciphered. And, like any language, even those deciphered words could have multiple meanings. What is known of the risks associated with some gene variants is drawn from decades of studying families at high risk of certain conditions. But we have little experience in population-based genetic testing in low-risk individuals. There is no doubt the type of screening planned will help some children and families, but it could also lead to unnecessary tests and treatment for a great many others.

There is much more to developing most conditions than a single genetic factor. A variant in the *HNF4A* gene illustrates the problem. People with a strong family history of a rare form of diabetes who carry this variant have a 75 per cent risk of developing the condition. However, the risk of diabetes in a person with this same variant who doesn't have a family history of the condition is only 10 per cent. We cannot assume that any gene variant will behave the same way in every population. Maybe those families with the *HNF4A* variant and high rates of diabetes are missing a protective gene that hasn't been discovered yet. Perhaps there is something in their shared environment that, when combined with their genetic risk, leads to diabetes.

SIMONE ROTELLA

The planned newborn-screening programme assumes that gene variants linked to disease convey a similar high risk in everybody, but that is unlikely to be correct. The work of looking for disease variants in healthy populations has only just started. Until it is complete, we cannot know how many people carry pathological variants that don't lead to conditions because they are protected by other factors. Do we really want newborns to be the population on whom we test our genetic hypotheses?

That is to say nothing of the ethical issues that will arise from this programme. How does one obtain informed consent from the parents of newborn children when testing for hundreds of conditions simultaneously? In the not-too-distant future, we could have a genetic database of every living person. How will this be protected and used going forward?

Of course, newborn screening is nothing new. The difference here is the huge range of conditions to be screened, the challenge of interpreting the results and the sensitivity of the information gathered. I am concerned parents will feel obliged to accept this testing, but won't be adequately apprised of all the unknowns. I am concerned that the vital early stages of life will be disrupted by hospital visits that might prove unnecessary. I am concerned that parents and paediatricians will be weighed down by a decision to subject a currently healthy child to potentially invasive tests and treatments.

The sensible thing is to gather more information on the prevalence and behaviour of disease variants in the general population before genetic testing becomes a speculative screening tool in children. While some will benefit, those success stories may turn out to be tiny compared with all the potential harms. ▮

Suzanne O'Sullivan is a neurologist and author of *The Age of Diagnosis: Sickness, health and why medicine has gone too far*

Field notes from space-time

Vastly, hugely, mind-bogglingly big

The awe-inspiring distances of the cosmos are hard to visualise, so how can we be certain we're measuring them correctly? **Chanda Prescod-Weinstein** explains

Chanda Prescod-Weinstein is an associate professor of physics and astronomy, and a core faculty member in women's studies at the University of New Hampshire. Her most recent book is *The Disordered Cosmos: A journey into dark matter, spacetime, and dreams deferred*

Chanda's week

What I'm reading
For reasons that will become public, a lot of Alice's Adventures in Wonderland.

What I'm watching
I finally saw and enjoyed Station Eleven.

What I'm working on
I have been thinking a lot about what quantum fields really are. Strange!

This column appears monthly. Up next week: Graham Lawton

ONE of the big challenges in communicating about space and space-time is that the universe is so large the scales are very difficult to imagine. Even just trying to get a sense of our solar system can be hard. If I were to make a scale-accurate model in which the sun is 1 centimetre across, I would have to put Pluto 42 metres away. I don't know about your house, but mine doesn't have a ballroom in it – which would be about that length.

Yet our solar system is tiny on the scale of the Milky Way. Ignoring the fact our galaxy exists in a halo of invisible dark matter that extends well beyond the visible parts, the Milky Way is so large that it would take light about 100,000 years to cross it. In contrast, light gets from the sun to Pluto in just 5.5 hours.

You might have noticed that I switched from everyday distances to units that relate to light speed. A hundred thousand light years is 9.46×10^{20} metres. How would I even tell you to visualise that? I might as well say it is a bajillion ballrooms. And the Milky Way is pretty small compared with the cosmos. It isn't even an especially large galaxy. Our neighbour Andromeda is twice as wide.

On top of that, space-time is expanding. That doesn't affect distance measurements in gravitationally bound regions like our solar system or the Milky Way. It doesn't even necessarily affect the distances between galaxies: the Milky Way and Andromeda are actually headed for each other, although the eventual collision will be more like a gentle dance than cars crashing, and it is 4.5 billion years away at least, so have no fear!

But on the largest scales, space-time is stretching, and groups of galaxies are being pulled away from each other. This is known as the Hubble expansion, and it means that many measurements of distance in the universe will change. Billions of years from now, people will get a different figure for the gap between us and the Virgo galaxy cluster, which is currently 50 million light years away.

In principle, these numbers are awe-inspiring, but it is also understandable that they invite some scepticism. First of all, how can we be so certain about these measurements? This is actually a subtle issue in astronomy. The way we do this is by building a "ladder" of measurements, often using objects of known brightness such as certain types of stars, that allow us to gauge distance.

> **"In our images of distant galaxies, why don't we see them as a blur, given that space-time is expanding?"**

The lowest – easiest – rung involves using cepheid variable stars, which pulse regularly, to calculate how far away things are. These are effective up to a certain distance, at which point we have to switch to something else. For the past 30 years, astronomers have used specific types of supernovae, or dying stars, because we know how to characterise the way in which their light is stretched out by the expansion of space-time. There are other ways too, some using what we know about the brightest red giant stars.

We have a high level of confidence in our ability to measure long distances, but I do understand why, despite this, I have received a few questions from readers related to this. One is about what happens to light as the universe expands. A standard part of our cosmological picture is that, just as the frequency of a siren that is moving away from us is shifted down, light waves stretch as space-time expands, reddening the light. Measuring this redshift is crucial to our use of supernovae to gauge distance, as mentioned earlier.

Redshift also means the light is of lower energy than it was before. But there is no apparent place the lost energy goes, which looks suspicious. Usually, when we get rid of energy, it goes somewhere. That is required in Newtonian physics. It isn't, however, in general relativity. In other words, the thing that makes it possible for us to measure long distances is also something that violates our day-to-day notions about how energy moves about in the universe.

Another, related question that came in recently from a reader is about pictures of distant galaxies, like the ones among the new Vera C. Rubin Observatory's first images. Shouldn't we see the galaxies as a blur, as space-time is expanding?

The important thing to keep in mind here is that "seeing" the expansion of space-time isn't like watching Lewis Hamilton in F1. It is a lot more like watching F1 if a race took billions of years, really, really far away. On that scale, the cars wouldn't visibly move. The only way we know that galaxies are moving away from us at all is by measuring something like redshift, and that is just a measurement of how the light is stretched out, not an observation of the galaxy's real-time motion.

I especially like these kinds of questions because they go to the heart of the metaphors we science communicators use to talk to our audiences. I appreciate that *New Scientist* readers are pushing these metaphors to their limits!

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Dying to live

Kat Zhou
California Academy of Sciences

THIS alien and extraordinarily intimate image provides a rare glimpse of a Caribbean reef octopus (*Octopus briareus*) mother and her potential offspring at the Blue Heron Bridge dive area, off Florida's West Palm Beach.

After mating, these solitary animals hide themselves far away to get on with the business of guarding their growing eggs. But for *Octopus briareus* and many other octopus species, the story has a nasty ending.

After a mother octopus lays a clutch of a few hundred eggs, she stops eating; she will die shortly after the eggs hatch. In 2022, research shed light on this process. The lifespan and reproduction of these octopuses are controlled by optic glands, the animal's main neuroendocrine centre, which is roughly the equivalent to the pituitary gland in vertebrates.

The optic gland of octopus mothers undergoes a massive increase in cholesterol production after mating, which may trigger a self-destructive spiral. But the reason for this cycle is still unclear. One idea is that it stops the octopus from eating its own young.

This shot, *Octopus Mother*, won freelance nature photographer Kat Zhou the Aquatic Life category in the 2025 BigPicture Natural World Photography Competition, which is open to all photographers, professional or amateur.

The contest is presented by the California Academy of Sciences and aims to celebrate and illustrate the diversity of life on Earth and prompt action to protect and conserve it.

Liz Else

Think of the children

To stop Earth's population plummeting, we must find ways to persuade people to have more babies, warns a provocative book. **Michael Le Page** explores

Book
After the Spike
Dean Spears and Michael Geruso
Bodley Head (UK); Simon & Schuster (US)

PHILIPPE MONTIGNY/ISTOCKPHOTO/GETTY IMAGES

FOUR-FIFTHS of all the humans who will ever be born may already have been born. The number of children being born worldwide each year peaked at 146 million in 2012 and has been falling overall ever since. This means that the world's population will peak and start to fall around the 2080s.

This fall won't be gradual. With birth rates already well below replacement levels in many countries including China and India, the world's population will plummet as fast as it rose. In three centuries, there could be fewer than 2 billion people on Earth, claims a controversial new book.

"No future is more likely than that people worldwide choose to have too few children to replace their own generation. Over the long run, this would cause exponential population decline," write economists Dean Spears and Michael Geruso in *After the Spike: The risks of global depopulation and the case for people*.

This, you might think, could be a good thing. Won't it help solve many environmental issues facing us today? No, say the authors. Take climate change: their argument isn't that population size doesn't matter, but that it changes so slowly that other factors such as how fast the world decarbonises matter far more. The window of opportunity for lowering carbon dioxide emissions by reducing population has largely passed, they write.

Spears and Geruso also make the case that there are many benefits to having a large population. For instance, there is more innovation, and economies of scale make the manufacture of things like smartphones feasible. "We get to have nice phones only because we have a lot of neighbors on this planet," they write.

So, in their view, our aim should be to stabilise world population rather than letting it plummet. The problem is we don't know how, even with the right political will.

While some government policies have had short-term effects, no country has successfully changed long-term population trends, argue the authors. Take China's one-child policy. It is widely assumed to have helped reduce population growth – but did it? Spears and Geruso show unlabelled graphs of the populations of China and its neighbours before, during and after the policy was in place, and ask the reader which is China. There is no obvious difference.

"As we grow richer, we are more reluctant to abandon career and leisure opportuntiies to have children"

Attempts to boost falling fertility rates have been no more successful, they say. Birth rates jumped after Romania banned abortion in 1966, but they soon started to fall again. Sweden has tried the carrot rather than the stick by heavily subsidising day care. But the fertility rate there has been falling even further below the replacement rate.

All attempts to boost fertility by providing financial incentives are likely to fail, Spears and Geruso argue. While people might say they are having fewer children because they cannot afford larger families, the global pattern is, in fact, that as people become richer they have fewer children.

Rather than affordability being the issue, it is more about people deciding that they have better things to do, the authors say. As we grow richer, we are more reluctant to abandon career and leisure opportunities to have children. Even technological advances are unlikely to reverse this, they say.

On everything other than the difficulty of stabilising the population, this is a relentlessly optimistic book. For instance, say the authors, dire predictions of mass starvation as the world's population grew have been shown to be completely wrong. The long-term trend of people living longer and healthier lives can continue, they suggest. "Fears of a depleted, overpopulated future are out of date," they write.

A large population may enable innovation and economies of scale

Really? Spears and Geruso also stress that the price of food is key to determining how many go hungry, but fail to point out that food prices are now climbing, with climate change an increasing factor. I'm not so sure things are going to keep getting better for most people.

This book is also very much a polemic: with Spears and Geruso labouring their main points, it wasn't an enjoyable read. That said, if you think that the world's population isn't going to fall, or that it will be easy to halt its fall, or that a falling population is a good thing, you really should read it.

Slay the new slang

Social media is turbocharging the evolution of language. Millennial **Victoria Turk** finds a guide to help us keep up

Book
Algospeak
Adam Aleksic
Ebury (UK, 17 July)
Knopf (US, 15 July)

NOTHING makes you feel old like being bamboozled by slang. Even the chapter titles of Adam Aleksic's *Algospeak: How social media is transforming the future of language* have this effect. "Sticking Out Your Gyat For The Rizzler" and "Wordpilled Slangmaxxing" remind me that, as a millennial, I am as close in age to boomers as I am to today's Generation Alpha.

Aleksic, a linguist and content creator (@etymologynerd), sets out to illuminate a new era of language innovation driven by social media, particularly short-form video platforms such as TikTok. The "algospeak" of the book's title is conventionally used to describe euphemisms and other ways to get round online censorship, with recent examples including "unalive" (referencing death or suicide) or "seggs" (sex).

But the author makes the case for expanding the definition to include all aspects of language influenced by "the algorithm" – which is itself a euphemistic term to describe the various, often highly secretive processes social media platforms use to decide which content to serve to users and in what order.

Aleksic draws on his experience making a living online – in his case, through educational videos about language. Like any content creator, he is incentivised to appease the algorithm, and this means choosing words carefully. A video he made on the etymology of the word "pen" (tracing back to the Latin "penis") fell foul of sexual content rules, while another analysing the controversial slogan "from the river to the sea" had its reach limited.

Meanwhile, videos on trending Gen Alpha terms, such as "skibidi" (a largely nonsense word with roots in scat singing) and "gyat" ("goddamn" or "ass"), performed particularly well. His experiences show how creators adapt their language for algorithmic gains, causing certain words to spread further online and, in the most successful cases, offline too. When Aleksic surveyed school teachers, he found many such terms have become regular classroom slang; some children even learn the word "unalive" before "suicide".

He is sharpest on his special subject, etymology, tracing how the algorithm propels words from online subcultures into the internet mainstream. The misogynistic incel community is the most prolific contributor to modern slang, he says, precisely because it is so radicalised, which can supercharge the development of an in-group language.

Aleksic remains mostly non-judgmental about language trends. "Unalive", he points out, is really no different from earlier euphemisms such as "deceased", while "skibidi" is akin to "Scooby-Doo". It is only recently that we categorised slang in terms of arbitrarily defined generations, which he argues is often inaccurate and lends a toxic framing to normal language evolution.

Things are slightly more complex when words owe their mainstream use to cultural appropriation. A lot of today's slang terms, like "cool" before them, can be traced back to Black communities ("thicc", "bruh"). Others have roots in the LGBTQ ballroom scene ("slay", "yass", "queen"). Widespread adoption can divorce these words from their history, which is often tied to social struggles, and can even reinforce negative stereotypes about the communities that spawned them.

It is hard to prevent this context collapse – such is the fate of successful slang. Social media has rapidly shortened timelines of linguistic innovation, which makes *Algospeak* an essential update, but also leads to it becoming out of date quickly. The underlying insights on how technology shapes language, however, will stay relevant – as long as the algorithm has its way. ▮

Victoria Turk is a London-based writer

Social media and short-form video platforms are driving language innovation

LISA5201/GETTY IMAGES

New Scientist *recommends*

Jacob Aron
News editor
London

Spaceflight has a gender problem. Depending on how you count, 700-ish people have been to space, but only about 100 of them are women. The recent all-female Blue Origin flight that

included Katy Perry saw more women go to space than during the whole 1960s and 70s.

Female spaceflight took off slowly only in the 1980s, so this decade is a perfect setting for **Atmosphere** by Taylor Jenkins Reid. The novel features Joan and Vanessa, astronauts who know they must work twice as hard as their male peers. The twist is their secret relationship. My mind boggled at the sad fact we could launch people into space, but not let them be in love.

Jenkins Reid is superb at conjuring characters in specific times and places. The book opens with a *Gravity*-style disaster, then rewinds to reveal the women's history.

I was impatient to get back to the action, but by the end all I cared about was the leads. If you're sick of sci-fi stuffed with big ideas but paper-thin characters, this is for you.

The TV column

High hopes

Foundation's third season is full of new characters and dramatic potential. But instead of mining those rich seams, too many plotlines feel undercooked. The show's decline is hard to watch, says **Bethan Ackerley**

Bethan Ackerley is a subeditor at *New Scientist*. She loves sci-fi, sitcoms and anything spooky. Follow her on X @inkerley

PATRICK REDMOND/APPLE TV+

Cassian Bilton plays Dawn, one of three clones who rule the galaxy

TV
Foundation
Apple TV+

Bethan also recommends...

TV
Andor
Disney+
Foundation *may satisfy history fans interested in cycles of civilisation. For a similar kick, try this* Star Wars *series, following a key player in the downfall of a very different empire. It is that rare thing: a show that stayed excellent throughout.*

Book
The Rise and Fall of the Galactic Empire
Chris Kempshall
Yes, it's more Star Wars*, but this account of the 24-year reign of Emperor Palpatine, written from the perspective of an in-universe historian, is such a fun read.*

MEL BROOKS and Carl Reiner used to spend every evening watching movies. Their favourites were cheesy – the type of film where someone says, "Secure the perimeter!" Why do I mention this in the context of *Foundation*? Because this adaptation of Isaac Asimov's novels started out as a thought-provoking series, but is now a "Secure the perimeter!" kind of watch.

It has been two years since *Foundation* last aired, so if you have forgotten where we left off, that is understandable. To recap: the galaxy has long been ruled by the Genetic Dynasty, a triad of clone emperors decanted at different ages to rule as Dawn, Day and Dusk. They are served by Demerzel (Laura Birn), the last robot in existence. Some 150 years after season two, the first Foundation, a society designed to replace the empire, now controls the outer planets.

The mind of Hari Seldon (Jared Harris), who predicted the fall of the empire via the mathematical field of psychohistory, was uploaded to a vault that opens shortly before a "Seldon crisis" is due. These crises are inflection points that could plunge the galaxy into thousands of years of darkness. Meanwhile, the second Foundation (a hidden colony of "mentalics" with telepathic abilities) works in the shadows to pre-empt a third Seldon crisis, which will be sparked by The Mule (Pilou Asbæk), a warlord and fellow mentalic. It is guided by another version of Seldon, with a physical body, and his protégée Gaal Dornick (Lou Llobell), who awaken for a few weeks each year to impart psychohistory's principles.

"It still looks gorgeous – a range of beautifully rendered planets make the universe feel unending"

That is the bare minimum you need to know heading into *Foundation*'s third season. It is a lot to take in, even before we add new characters into the mix: there's the first Foundation's ambassador, Quent (Cherry Jones), who maintains uneasy relations with the empire; Han Pritcher (Brandon P. Bell), an intelligence agent who moves between the two Foundations; and Toran Mallow (Cody Fern), the profligate descendant of the wily Hober Mallow from season two.

This should make for a complex world, populated by well-drawn characters. And sometimes the show retains a satisfying blend of drama and big ideas, particularly when Demerzel is involved. It still looks gorgeous – a vast range of beautifully rendered planets make the universe feel unending.

But here's the paradox: the lore and scale of *Foundation* should make it mentally stimulating, but too many of its plotlines have become absurd and shallow. The richest, most interesting elements of the show – the two Seldons, potential alliances between the empire and Foundations, even the skirmishes between the three emperors – remain largely unexplored. *Foundation* has the rhythms of intelligence without the substance. And that's before we get to the dialogue. The first time a character dropped a clunker like, "We've got company," I groaned. By the end, I was longing for a "Secure the perimeter!"

It is hard to see a good show go bad, harder still when a gleam of something special remains. I have seen nine episodes – and perhaps that final, 10th instalment will tie it all together, opening up the series like Seldon's vault and revealing a hidden plan at work. I'm doubtful. Your enjoyment may depend on whether you can switch off your brain and embrace *Foundation* for the crude satisfaction it occasionally offers, far from the jewel of TV it once was.

Editor's pick

We do have free will, but we are squandering it

7 June, p 8

From Howie Firth, Elgin, Moray, UK

Does free will exist? A simple thought experiment confirms it, surely. If every action we make is predetermined by the laws of physics, then it is possible to imagine constructing a computer that could predict what I will do at a particular moment. When I hear that prediction, I am then able to do something different. Whatever the computer says the predetermined act is, I will exercise my freedom of choice to counter it.

The real question is why, when we have the freedom and the power to choose to sustain the life of the planet that has given us so much, are we failing so miserably?

On the strange idea that space-time can remember

21 June, p 32

From Faith Anstey, Dalguise, Perth and Kinross, UK

Some believe religion promises immortality. Others trust their descendants to provide it, and a few hope their works of art will earn it. However, the existence of a non-physical "soul" is fraught with problems, while physical descendants and creations can take you only so far.

However, according to Florian Neukart's hypothesis, actions, once performed, can't be unperformed. They are now history and can't be erased from the memory of space-time. Might this be how our legacy persists?

From Adrian Cosker, Hitchin, Hertfordshire, UK

Neukart writes about his idea, quantum memory matrix (QMM), and his "suspicion that the whole of cosmic history is, in some sense, baked into space" as "we know information cannot be destroyed".

Could this idea perhaps ultimately lead to a "scientific" explanation of phenomena that, up to now, have been considered supernatural? We should recall that many phenomena, such as solar eclipses, the cycle of the seasons and more, were once regarded as supernatural, only to be explained as science developed.

From Sam Edge, Ringwood, Hampshire, UK

Whether Neukart's wider idea has any validity or not, just because some mathematical framework works for qubits in a computer, it doesn't go any way to proving that space-time itself consists of a completely different type of qubit.

From Celso Antonio de Almeida, Guareí, Brazil

I couldn't help but notice the similarities between the QMM idea and the concept of the Akashic record: a compendium of all things, present and future, held on a non-physical plane, proposed in connection with the religious movement of theosophy in the late 19th century. I wonder if the proponents of QMM have already realised this conceptual similarity.

This is why no one truly gets quantum physics

7 June, p 26

From John Maindonald, Wellington, New Zealand

Surely the reason *Why Nobody Understands Quantum Physics*, the title of a book you reviewed, is that attempts to describe and understand this part of physics in terms that make sense at the level of everyday experience are fraught. This shouldn't be a surprise – there is clearly a deep and mysterious substructure that underpins the macroscopic world. The best we can probably do is to "shut up and calculate". That is because the maths works, at least in those contexts where we can check it.

Put brain-waste massage idea to the razor test

14 June, p 11

From Erik Foxcroft, St Albans, Hertfordshire, UK

If Gou Young Koh and his colleagues want to find out if massaging the faces of people helps flush waste from their brains, as they found it does in mice, they could look for differences between the brains of deceased men who shaved every day and those who had well-grown beards. While the results would be sex-biased, and may be easier to do with certain nationalities, they could provide a quick preliminary check as to whether this works.

Let's get serious about the rise of Lyme disease

21 June, p 36

From Stephanie Woodcock, Carnon Downs, Cornwall, UK

In light of the findings of the study you mention that found 15 per cent of the global population have Lyme antibodies, it is perhaps no surprise to read that Lyme disease bacteria can persist in the body. The high seroprevalence indicates that asymptomatic people also have these antibodies. An unknown number of them won't know they harbour the infection. Researcher Richard Marconi singles out the northern hemisphere as being particularly prone to this. Arguably, then, wealthy, high-income nations need to be very aware of the risks.

That false negative testing occurs, that some people who have been fully treated still find themselves ill, won't be news to Lyme patients. It reflects what they have been saying for years.

There is no place for the complacency that UK patients have been subject to. Planning, in light of Lyme disease and the many other vector-borne diseases, must step up a gear as temperatures increase.

Time to stop using mouthwash?

21 June, p 40

From Lyn Williams, Cilfrew, Neath Port Talbot, UK

In your look at the importance of the microbiome of the small intestine, you quote Gray Frost as saying that "most of these microorganisms are derived from the oral microbiome". In which case, maybe we should question the use of things like mouthwash.

One of the greatest smells in the known universe

24 May, p 30

From Bethany Snyder, Elk Grove Village, Illinois, US

One of the most pleasant smells in my life is your magazine! I look forward to its scent immensely and get to sniffing it as soon as the freshly printed pages arrive. I hope this counts as the smell therapy you wrote about, and that I am staving off dementia by doing so.

Two more ways to keep the tears from your eyes

24 May, p 12

From Agatha Windig, Rochester, New York, US

During the years that I was wearing hard, gas-permeable contact lenses, I had no problem cutting onions without crying. It must be the iris and the pupil, in particular, that are affected by onion particles, right?

From Keith Macpherson, Clevedon, Somerset, UK

Keep onions in the fridge and chop them while they are cold. It seems to do the trick to avoid tears. ▮

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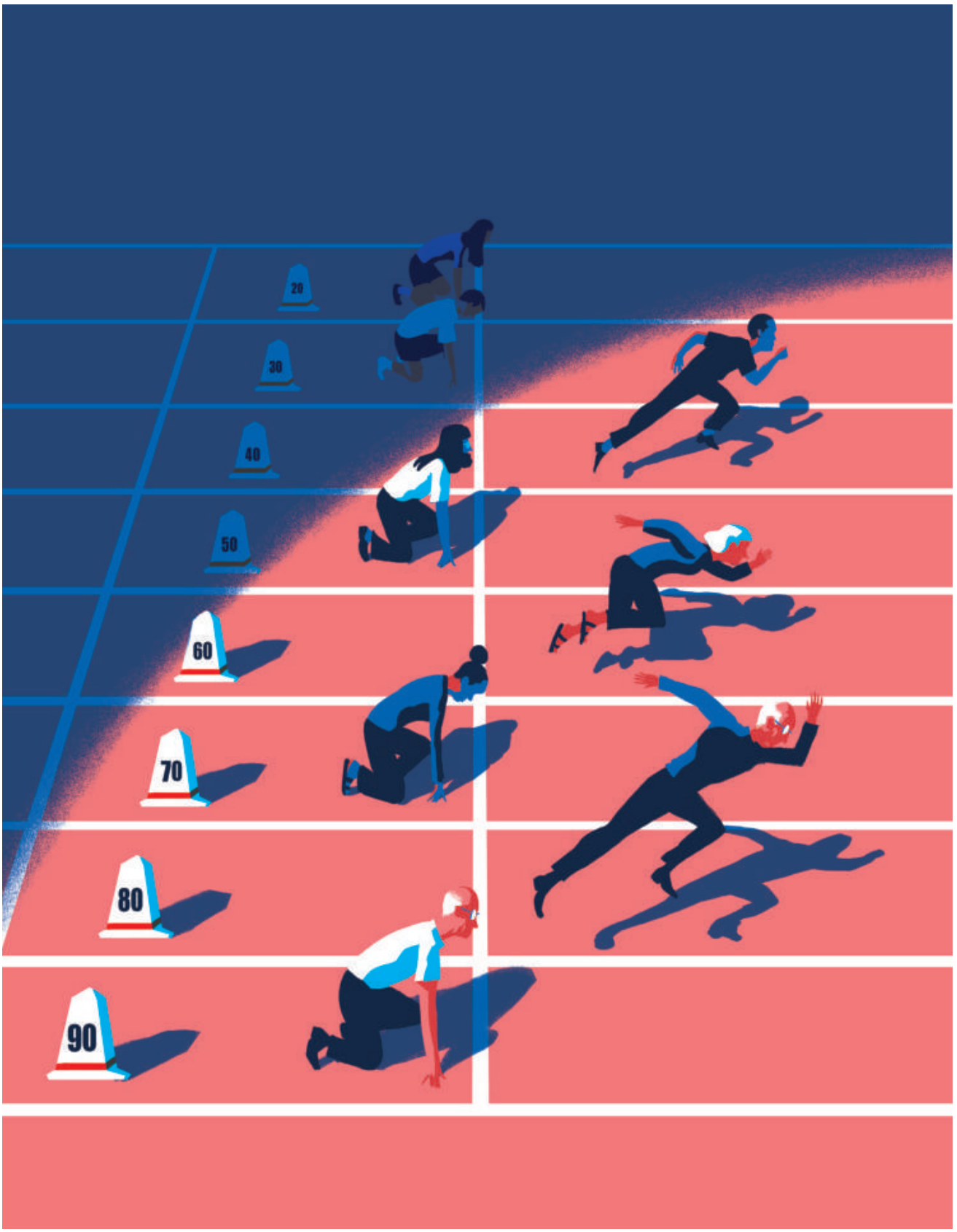


PAUL BLOW

Ageing, fast and slow

We have long thought there is a slow, steady decline into old age, but it turns out we actually experience three rapid periods of ageing, finds **Graham Lawton**

AT AROUND the age of 40, Maja Olecka's friend suddenly found she could no longer handle her drink. Quantities of alcohol that she would have shrugged off in the past now knocked her for six. Her hangovers got much worse.

Olecka's friend certainly isn't alone – when I was around that age, I heard similar stories from friends, many of whom quit drinking. But Olecka, a researcher at the Leibniz Institute on Aging – Fritz Lipmann Institute in Jena, Germany, thinks she knows why it happens.

At this age, she says, many people experience a rapid burst of ageing, altering their ability to metabolise alcohol. And that, unfortunately, isn't all. This sudden ageing, reflected in dramatic molecular shifts, comes with an acceleration in muscle wastage and skin decline. Immune cells die off swiftly and there are substantial increases in the risk of cardiovascular disease and of dying. Research also suggests that this surge of ageing happens again, at around 60 and 80.

Ageing, it turns out, might not be the steady downhill slide from the uplands of youth to the perpetual après-ski in the sky we all thought. "Many contemporary definitions of ageing are describing it as a gradual, linear process," says Olecka. "We have to abandon this assumption."

Instead, it might be more like whitewater rafting: long stretches of calm punctuated by sudden periods of turbulence, punching holes in your raft until you eventually sink. This surprising discovery is still at an early stage, but it could have profound implications – not just for our understanding of ageing, but also for our efforts to slow it down.

The first hints that ageing proceeds in instalments came from studying Smurfs – not the small, blue cartoon characters, but small, blue fruit flies.

In 2011, Michael Rera, then at the French National Institute of Health and Medical Research in Paris, discovered that flies from the species *Drosophila melanogaster* enter a distinct phase towards the end of their natural lives. Feeding the flies blue dye – initially as a way to measure their food intake – turned them blue, hence the name "Smurf". But the flies only became blue after reaching a certain age: older fruit flies have leaky guts, so when they consume the dye, it seeps out into their body cavity, turning them blue.

This blue state, and intestinal permeability that causes it, is a reliable indicator that the fly is about to die – and soon. The flies enter Smurfdom very rapidly: one day they are fine, the next they are blue, and not long after, they are dead. The Smurf state is also characterised by some classic signs of decrepitude, including decreases in spontaneous motor activity (they move less) and energy stores. This led Rera – now at the Jacques Monod Institute in Paris – to propose that the *Drosophila* ageing process is biphasic, chugging along slowly for most of a fly's adult life and then suddenly flipping into a profoundly more decrepit state. This may be because the flies can withstand accumulation of molecular damage for a long time, but then hit a threshold that they can no longer bear.

Abrupt shifts

Smurfdom has since been observed in other organisms, including nematode worms and zebrafish, hinting that the gut permeability it indicates is a common feature of ageing.

Humans, fortunately, don't turn blue the closer we get to death. But over the past few years, evidence has accumulated that we, like fruit flies, experience similar rapid escalations in how we age, possibly for similar reasons.

In 2022, for example, a team at the Wellcome Sanger Institute in Hinxton, UK, discovered a major and rapid transition in the ability to make new blood cells around the age of 70. Up to that point, most people have a strong and stable population of 20,000 to 200,000 haematopoietic stem cells pumping out new red and white blood cells and platelets. But after 70, that drops precipitously, such that the majority of new blood cells are made by just hundreds or even tens of stem cells. This hugely raises the risk of anaemia and other conditions characterised by reduced blood cells, along with immune system dysfunction, poor tissue regeneration and blood cancer – all of which increase the risk of death and were known to suddenly surge in the over-70s.

The cause of this abrupt collapse seems to be that most of these haematopoietic stem cells finally succumb to the molecular damage that has accumulated across their lifespan. According to Steve Hoffmann, Olecka's colleague at the Leibniz Institute on Aging, this is a classic tipping point, when a system undergoes an abrupt shift from one equilibrium to another, often irreversibly, after a long, slow build-up of pressure.

The concept is familiar in physics, ecology and climate science, but Olecka and Hoffmann want to bring it into ageing research – carefully. "It's a tricky term because there is no strict scientific definition of a tipping point and different fields use it in different ways," says Olecka. "But I think it is a very good term to convey the general concept of abrupt change after crossing some threshold."

Olecka and Hoffmann's idea draws on mounting evidence that, in multiple areas and systems in the body, ageing processes are amplified after critical biological limits are breached. Researchers have uncovered other such tipping points, many of them at roughly the same age. In the late 2010s, for instance, a team led by Tony Wyss-Coray at Stanford University in California became interested in heterochronic parabiosis, a gruesome procedure whereby the circulatory systems ›

PAUL GLENDELL/ALAMY

MARTIN PARR/MAGNUM PHOTOS

Staying active is one way to stave off the effects of ageing

of two animals are surgically connected. In a 2011 study, Wyss-Coray and his colleagues connected the circulatory systems of an ageing mouse and a young mouse, discovering that the procedure rejuvenated the old mouse and aged the young one. Their findings suggested that blood – more specifically its fluid portion, plasma – contains key regulators of ageing.

To see what those might be, he and his colleagues tracked how proteins in plasma change over the course of human ageing. In a study published in 2019, they took blood from 4263 people aged from 18 to 95 and measured the levels of 2925 proteins in the plasma. They expected to see gradual, linear changes with increased age, but they didn't.

To their surprise, they found that the participants clustered into four groups: the under-34s, those aged 34 to 60, people aged 61 to 78 and the over-78s. Within each group, the protein profiles were very similar, but at the ages of 34, 60 and 78, they suddenly changed, with levels of some proteins rising dramatically while others plummeted. What's more, some of the proteins that became enriched in the older age groups were already known to be associated with cardiovascular disease and Alzheimer's. The researchers also found enrichment of a protein associated with Down's syndrome. None of the participants had Down's, but one consequence of the syndrome is accelerated ageing. Their conclusion was that humans appear to undergo three rapid pulses of ageing around the ages of 34, 60 and 78.

In an even deeper dive, a team led by Michael Snyder at Stanford University looked at RNA, metabolites, lipids and inflammatory molecules as well as plasma proteins in 108 people aged between 25 and 75. The researchers found that molecules that were already known to be markers of ageing spiked dramatically during two brief windows, first in the early to mid-40s and then at around 60. Both spikes included molecules associated with an increased risk of cardiovascular disease, dysfunctional lipid metabolism (which can cause the harmful build-up of fats or fat-like substances in cells and tissue), decreased muscle stability and diminished skin integrity, rendering it more vulnerable to damage and infection. But both had unique features too. The first spike came with declines in the ability to metabolise caffeine and alcohol efficiently, explaining the middle-aged hangover problem. The second spike hinted at precipitous declines in kidney function and the immune system.

"What we discovered is that most things aren't changing linearly," says Snyder. Only 6.6 per cent of the thousands of molecules tracked with age; 81 per cent changed non-linearly. The fact that the timing of the spikes roughly corresponds to the first two seen by Wyss-Coray's team at 34 and 60 suggests that they are picking up the same signals, he says. His team was unable to see if there was a spike at 78 because their oldest subjects were only 75.

There are signs that organs and systems also age in stages. In 2020, for example, researchers in Germany made molecular profiles of skin samples taken from women aged 21 to 76. They found, unsurprisingly, that skin from older women had more molecular markers

The ageing tipping points

Though there are some outliers, many of the systems and organs in our bodies seem to tick along at a steady rate until they suddenly exhibit signs of decline at around the same ages.

Transition period	Approximate age	Major changes
Young adulthood to middle age	~40	Molecules associated with ageing show their first spike, indicating age-related changes in lipid metabolism and the onset of muscle wastage and loss of skin integrity. The risk of cardiovascular disease rises from 16 per cent to 40 per cent, while the risk of developing Parkinson's and Alzheimer's disease also goes up. The immune system's function declines, as does the ability to metabolise alcohol and caffeine. The mortality rate accelerates slightly.
Entry to late middle age	~60	The brain's age increases significantly and the risk of Parkinson's and Alzheimer's rises again. The risk of cardiovascular disease jumps to about 75 per cent, and there is a major decline in kidney and immune system functioning. Molecular markers of skin ageing increase, and mortality rates accelerate again.
Start of old age	~80	Blood stem cells die off in large numbers. There are increased markers of ageing in the brain's plasma proteome, and major shifts in levels of proteins in blood plasma. The risk of cardiovascular disease increases to 85 per cent.

of ageing. But the journey from young to old skin is wrinkly, with tipping points at around 30, 50 and 65, segmenting skin ageing into four distinct phases. Tipping points have been discovered in the brain's plasma proteome, the collection of proteins found in blood plasma, at 57, 70 and 78, coinciding with an increase in biomarkers of ageing. And some key immune system cells, including B-cells, T-cells and natural killer cells, experience two bursts of decline and ageing around the ages of 40 and 65, probably contributing to the weakening immune function that is a hallmark of ageing.

The tipping points may also underlie some hitherto puzzling patterns in the occurrence of age-related diseases and death. According to Snyder, we already know that the incidence of certain age-related diseases exhibits step changes. The risk of developing cardiovascular disease, for instance, increases from 16 per cent to 40 per cent at age 40, then stays roughly flat until age 59. The risk then jumps to about 75 per cent at 60, and again to about 85 per cent after 80. Similarly, the incidence of Parkinson's and Alzheimer's diseases accelerates first more gently at around 40 and then again more aggressively at roughly 65.

Ageing instalments

Mortality data also shows subtle non-linearities. The long-standing assumption is that mortality rates rise smoothly and exponentially throughout adulthood, such that the risk of dying from any cause doubles roughly every eight years. But when Aleksei Golubev at the N. N. Petrov National Medical Research Center of Oncology in Saint Petersburg, Russia, took a close look at data from France, Sweden and Japan, he unexpectedly found three periods where the mortality rate slightly but discernibly accelerates – around the ages of 17, 38 and 60. The first of these is probably down to extrinsic factors such as accidents, according to Hoffmann, but it is intriguing that the other two coincide with molecular tipping points. They may, therefore, be partly due to accelerated ageing at those times.

If you amalgamate all the ageing tipping points – making allowances for some outliers, such as skin ageing – it appears that once we reach maturity, our lives are roughly divided into phases lasting about 20 years. "I think we need more data, but from what I see, the most important transitions in humans are around 40, around 60 and then around 80," says Olecka.

You might say we know that intuitively – we generally refer to these phases as young adulthood, early middle age, late middle age and old age (see "The ageing tipping points", left). But research tells us that these informal labels are genuine life stages with distinct biological characteristics.

MARTIN PARR/MAGNUM PHOTOS

We reach one of the ageing tipping points in our 60s

So, what precipitates these sudden shifts? According to Olecka and Hoffmann, it is probably accumulated molecular damage that eventually overwhelms the body's ability to deal with it, not unlike what happens to the fruit flies. Our natural repair systems can buffer these molecular changes up to a point, but then become swamped or exhausted, causing the system to slump into a new state. This is hypothetical for now, but some possible buffers are DNA repair (the cellular processes that identify damage to DNA molecules and correct them), antioxidants and the molecular "chaperones" that ensure the correct folding of proteins. There could also be domino effects, where crossing one tipping point pushes another over the threshold, they say.

Snyder suspects that the transition around 40 is partly down to lifestyle changes. "My guess is that people are not exercising as much, they become more sedentary and they're probably not eating as well," he says, "and it catches up with them when they hit their early 40s."

That holds out the prospect of delaying the arrival of tipping points with diet, exercise and, maybe one day, a new class of pharmaceuticals tentatively called "anti-transition agents". Though not all ageing processes follow non-linear dynamics – mutation accumulation, for example, is linear – Hoffmann notes that "these non-linear transitions are exceptionally interesting". Exploring them could open new targets for anti-ageing therapeutics.

"For now, people are looking for anti-ageing medication that would work for everyone, but maybe we should look for strategies to stop or delay the transitions," says Olecka. "This may be a more successful and more targeted approach." Such drugs are a long way off, but steps have already been taken in the form of genetic interventions that Rera's team has designed to postpone fruit flies' entry into the Smurf state.

In the meantime, Olecka and Hoffmann envisage translating the basic research into a stratification system for ageing, whereby people are assigned to one of the four, or maybe even five or six, stages and treated accordingly. "We think that the transitions may mark natural boundaries between stages of ageing and be useful for prevention," says Olecka. "Some interventions may be beneficial in a younger stage, but be detrimental in the older stage of age." Again, the specifics await discovery.

So once the Rubicon has been crossed – after an age stage has been reached – is there any going back? "This is a very, very important question to answer," says Olecka. "We don't know yet."

But we could know soon. Snyder, for one, is crunching data from a bigger group of people he followed for 12 years. One of his aims is to find out which interventions might delay the tipping points. "By tracking people's lifestyles, we'll get a better feel for if some people are able to push these changes into their 50s or later," he says. "And if so, what were they doing to make that happen?"

With the accumulation of such compelling evidence and new research under way, as Hoffmann says, the field of ageing research may itself be approaching a tipping point. ▮

Graham Lawton is a staff writer at *New Scientist*

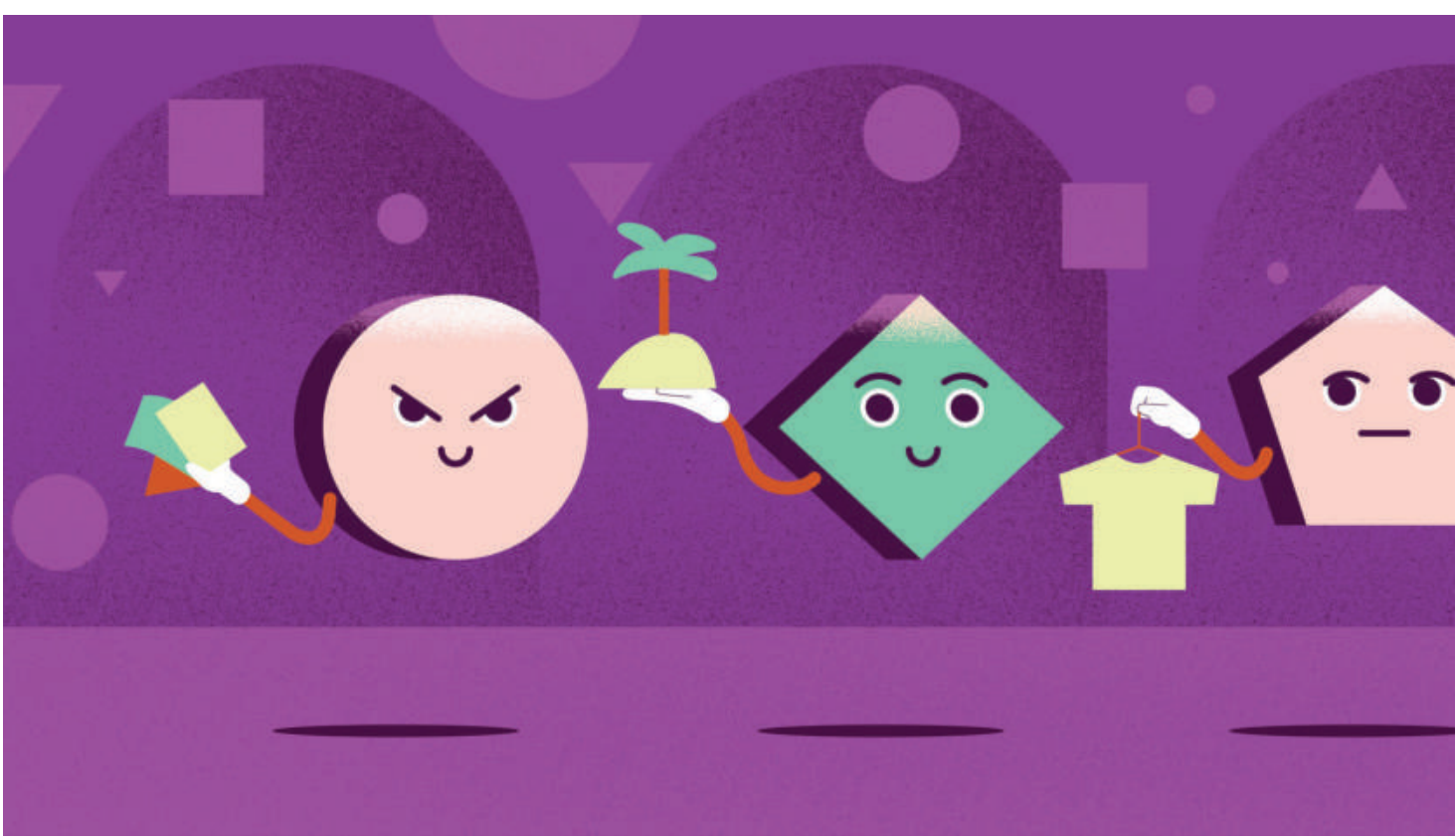
AI at your service

AI assistants promise to free up our time by doing boring tasks for us. **Chris Stokel-Walker** let them run his day to see if they are up to the job

I WILL never forget the kung pao chicken I sat down to eat a few months ago. Not because the taste blew me away – 20 minutes on the back of a delivery rider's scooter had sullied that somewhat. What made the meal memorable was that I hadn't really ordered it at all. Yet there it was, in front of me.

An AI assistant called Operator, developed by ChatGPT-maker OpenAI, had ordered the food on my behalf. The tech industry has dubbed such assistants "AI agents", and several are now commercially available. These AI agents have the potential to transform our lives by carrying out mundane tasks, from answering em ails to shopping for clothes and ordering food. Microsoft chief financial officer Amy Hood reportedly said in a recent internal memo that agents "are pushing each of us to think differently, work differently" and are "a glimpse of what's ahead". In that sense, my kung pao chicken was a taste of the future.

But what will that future be like? To find out, I decided to put Operator and a rival product named Manus, developed by Chinese start-up Butterfly Effect, through their paces. Working with them was a mixed bag: amid the flashes of brilliance, there were moments of frustration,



MICHAL BEDNARSKI

too. In the process, I also got a glimpse of the risks to which we are exposing ourselves. Because fully embracing these tools requires handing them the keys to our finances and our list of social contacts, as well as trusting them to perform tasks the way we want them to. Are we ready for the world of AI agents, or will they be hard to stomach?

Since 2023, we have lived in the era of generative AI. Built using large language models (LLMs) and trained on huge volumes of data scraped mainly from web pages, generative AI can create original content such as text or images in response to commands given in everyday language. It would be fair to say that this AI has made quite a splash, judging by the volume of media coverage devoted to the technology, and has already changed the world significantly.

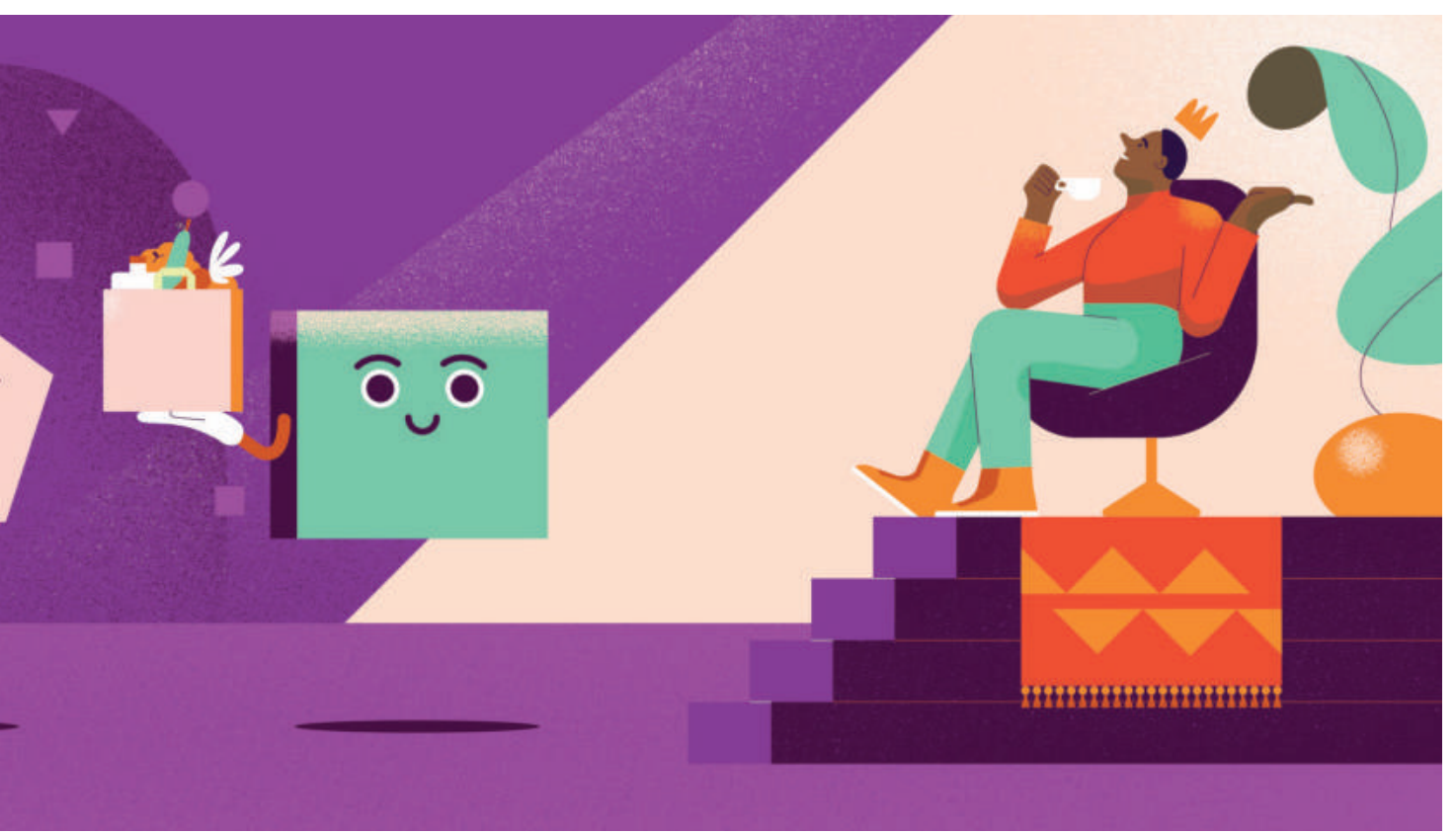
Agentic AI promises to take things one step further. It is "empowered with actually doing something for you", says Peter Stone at the University of Texas at Austin. Over the past few years, many of us have grown used to the idea of asking a generative AI for information – recommendations of favourite dishes available in the neighbourhood, for instance, and contact details for the restaurants from which that food can be ordered. But ask agentic AI, "What should I eat tonight?" and it can pick out dishes it thinks you will like from a restaurant's website and – if there is an online order form – pay for the food using your credit card, arrange for it to be sent to your home and let you know when to expect the delivery. "That will feel like a fundamentally different experience," says Stone: AI as an autopilot rather than a copilot.

Personal shopper

Building an agentic AI with this sort of capability is trickier than it might appear. LLMs are still the driving force under the surface, but with agentic AI, they focus their processing power on the decisions they can make and the real-world actions they can take based on the digital tools – including web browsers and other computer-based apps – at their disposal. When given a goal such as "order dinner" or "buy me some shoes", the AI agent develops a multi-step plan involving those digital tools. It then monitors and analyses how close the output at each step is to the ultimate goal, and reassesses what else needs to be done. This process continues until the agent is satisfied it has reached the ultimate goal – or come as close to doing so as possible. And once the act is done, the system asks whether it achieved the goal successfully, a form of feedback also present in AI chatbots, called reinforcement learning from human feedback.

Stone, who is the founder and director of the Learning Agents Research Group at his university, has spent decades thinking about the possibility of AI agents. They are, he says, systems that "sense the environment, decide what to do and take an action". Put in those terms, it may feel as if AI agents have been with us for years.

For instance, IBM's Deep Blue computer appeared to have reacted to events on a real-world chessboard to beat former World Chess Champion Garry Kasparov in 1997. But Deep Blue wasn't an agentic AI, says Stone. "It was decision-making, but it wasn't sensing or acting," says Stone. It relied on human operators to move chess pieces on its behalf and to inform it about Kasparov's moves. An AI agent doesn't need human help to interact with the real world. "Language models that were disembodied or disconnected from the ›



YAU MING LOW/ALAMY

AI agents could soon order food deliveries or take care of our work admin

KUAN CHANG CHEN/MILLENNIUM IMAGES, UK

world are now being connected [to it]," he says.

Early versions of these agentic AIs are now available from many tech firms, with each, whether it is Microsoft, Amazon or the software firm Oracle, offering its own. I was eager to see how they work in practice, but doing so isn't cheap: some come with annual subscription fees running to thousands of dollars. I reached out to OpenAI and Butterfly Effect and asked for a free trial of their products – Operator and Manus, respectively. Both accepted my request. My plan was to use the AIs as personal assistants, taking on my grunt work so I would have more free time.

The results were mixed. I was due to give a presentation in a few weeks, so I uploaded my slide deck to Manus's online interface and asked the AI agent to reformat it. Manus seemed to have done a good job, but after opening the slide deck in PowerPoint, I realised that it had placed every line of text in a separate text box, meaning it would be annoyingly fiddly for me to make additional edits myself. Manus did, however, fare better at compiling code for an app I wanted to upload into an app store-ready format, using various tools and its remote computer's command line to do so.

Turning to Operator, I began by asking the AI agent to handle my online invoicing system. Like a well-meaning but not particularly helpful intern, it insisted on filling out the form the wrong way: inputting text defining the work for which I was invoicing into a box that could receive only numeric codes. I eventually managed to break it out of that habit, but then Operator got confused when copying over details from my "to invoice" list to the system, with potentially embarrassing results. Notably, it suggested I submit an invoice to the *New Scientist* accounts team asking for an £8001 payment for a single article.

It was with some trepidation, then, that I gave Operator a promotion and asked for its help in reporting this story. I had already used ChatGPT to identify AI experts who could comment on the rise of agentic AIs. I asked Operator to send each expert an email on my behalf requesting an interview. The results, which I didn't see until the emails had already been sent, made me inwardly cringe – not least because Operator decided against acknowledging its role in composing them, giving the impression that I had written them myself. The language the AI agent used was simultaneously naive and too formal, with staccato sentences fired with a semi-hostility that put me – and, in all likelihood, the would-be interviewees – on edge. Operator also failed to mention some key information, including that my story would be published by *New Scientist*. In that way, it felt a lot like a junior assistant. Not really knowing how to write an email as I would, Operator made many mistakes.

Risky business?

In Operator's defence, however, the emails were at least partially successful. It was through an Operator email that I made contact with Stone, for instance, who took the AI-sent email in his stride. Another researcher complimented me on the approach when I later disclosed that the email had been written by Operator. "That's serious dogfooding!" they said – tech slang for testing experimental new products – although they declined to speak for this story because the funders of a project they were working on wouldn't let them.

The tech companies behind these AI agents present the technology as if it is an indefatigable digital assistant. But the truth is that, in my experience, we aren't quite there yet. Still, assuming the tech is going to improve, how should we view these new tools? To start with, it is worth pondering the commercial incentives that underpin all the hype, says Carissa Véliz at the University of Oxford. "Of course, the AI agent works for a company before they work for you, in the sense that they are produced by a company with financial interests," she says. "What will happen when there are conflicts of interest between the company who essentially leases the AI agent and your own interests?"

We can already see examples of this in the early AI agents: OpenAI has signed agreements with companies to collaborate on its system, so when searching for holiday flights, Operator may prefer Skyscanner over competitors, or turn first to the *Financial Times* and Associated Press if you ask it about the news. Véliz also suggests users consider privacy concerns before leaping headfirst into using agentic AI, given the tech's access to our personal information. "The essence of cybersecurity is to have different boxes for different things," says Véliz – using unique passwords for online banking and email, for instance, and never saving those passwords in a single document – but to use an AI agent, we must break down the barriers between those boxes. "We're giving these agents the key to a system in which everything is connected, and that makes them very unsafe," she says.

It is a warning I can appreciate. I wasn't particularly happy that my trial with Operator necessarily involved ceding control of my email and accounting software to the AI

"What will happen when there are conflicts of interest between the company who essentially leases the AI agent and your own interests?"

agent – and my level of unease hit new heights when I asked Operator to order the dish of kung pao chicken on my behalf. At one point, the AI agent asked me to type my credit card details into a computer window that had popped up in the Operator chatbot interface. I reluctantly did so, even though I felt I didn't fully control the window and that I was placing an enormous amount of trust in Operator.

Moreover, as things stand, it isn't completely clear that AI agents have earned such trust. By definition, they tend to "access a lot of tools and interact a lot more with the outside world",

Would you allow an AI to choose your next holiday destination?

says Mehrnoosh Sameki, principal project manager of generative AI evaluation and governance at Microsoft. This makes them vulnerable to certain types of attack.

Tianshi Li at Northeastern University in Massachusetts recently looked at six leading agents, and studied those vulnerabilities. She and her team found that agents could fall prey to relatively simple tricks. For example, deep within the text of a privacy policy that few people would read, a malicious actor might hide a request to click a link and insert credit card details. Li's team found that an AI agent wouldn't hesitate to carry out the request. "I think there are a lot of very legitimate concerns these agents might not act in accordance with people's expectations," she says. "And there is no effective mechanism to allow people to intervene or remind them of this possibility and to avoid the possible consequences."

OpenAI declined to comment on the concerns raised by Li's research – although my experience using Operator suggests the company is aware of the trust-and-control issue. For instance, Operator seemed to go out of its way to constantly ping me notifications to check if the actions it wanted to take aligned with my expectations. The inevitable downside to that strategy, however, is that it made me feel that I was devoting so much time to micromanaging the agent's work that I would have been quicker just performing the tasks myself.

"We're still [in the] early days in a lot of these agentic experiences," admits Colin Jarvis, who leads OpenAI's deployed engineering team. Jarvis says the current crop of AI agents are far from achieving their full potential. "It still needs quite a bit of work to get that reliability," he says.

Butterfly Effect made a similar point. When I reached out to the firm to discuss my problems using its agent, I was told that "Manus is currently in its beta stage, and we are actively working on optimising and improving its performance and functionality".

Tech firms have arguably been struggling to get agentic AI working for several years. In 2018, for instance, Google argued that a version of an AI agent it had developed, called Duplex, was going to change the world. The company touted Duplex's ability to call up restaurants and reserve tables for its customers. But, for reasons unknown, it never took off as an everyday tool with widespread appeal.

Nevertheless, AI companies and tech analysts alike say the agentic AI revolution is just around the corner. The number of mentions of agentic AI on financial earnings calls at the end of last year was 51 times greater than it was in the first quarter of 2022. The interest here is not merely in using agents to assist human employees, but also to replace them. For example, companies including Salesforce, which helps businesses manage customer relations, are rolling out AI agents to sell services.

Stone doesn't think the technology is quite ready for that kind of application. "There's a lot of overhype right now," he says. "It's certainly not going to be within the next few years that all jobs are gone or that autonomous agents are doing everything." To make good on the most ambitious claims, he says, "fundamental algorithms... would need to be discovered".

Enthusiasm may be high because tools like ChatGPT perform so well that they have raised expectations of what AI can achieve more generally. "People have extrapolated to say, 'Oh, if they can do that, they can do everything,'" says Stone. Certainly, I found that agentic AI can work extremely well – some of the time. But Stone says we shouldn't infer from a few limited examples that AI agents can do it all.

On reflection, I am inclined to agree with him – at least until my version of Operator recognises that I consider no order from a Chinese restaurant truly complete without a side of prawn crackers. ▮

MARTIN PARR/MAGNUM PHOTOS

Chris Stokel-Walker is a science writer based in the UK

DAVID OLIETE

The enemy within

Humanity's innate treachery is behind a range of social ills, but we have a cultural immune system that helps us fight back, says social scientist **Jonathan R. Goodman**

NEARLY 2 million years ago, one of our hominin ancestors developed bone cancer in their foot. The fate of this individual is unknown, but their fossilised remains leave no doubt that cancer has been a part of our story for a very long time. It is also clear that, when threatened by our own normally cooperative cells turning against us, we evolved an immune system to help us identify and deal with the enemy within.

But treacherous cancer cells weren't the only internal threat our ancestors faced. As hypersocial beings, their survival was also jeopardised by selfish individuals attempting to subvert the group – and capable of unravelling society, just as a cancer eventually kills its host. I am interested in understanding how we adapted to this threat. At the heart of the story is this question: is human nature selfish or altruistic, competitive or cooperative? Are we essentially cancers, tamed by culture, or more like healthy cells in the human body, working together for mutual success?

People have debated this for centuries and continue to do so, citing research in primatology, anthropology, psychology and economics to defend their points. The answer has profound implications for how we aim to structure society. If we are born altruists, then institutions and hierarchies are unnecessary. But if selfishness prevails, strong control is essential. To me, both extremes are unconvincing. To understand why, we must appreciate the circumstances under which humanity has evolved. Determining how our ancestors confronted brutish selfishness doesn't just tell us about our own social past – it can also help us inoculate today's societies against the threat from within.

Look at the animals to which we are most closely related and you see that each species has its own distinct set of social structures. Among gorillas, for example, groups of unmated males are typically led by aggressive alpha males. Mated gorillas sometimes live in groups of males and females, but more often it is the stereotypical silverback with a harem of females – a group that has its own hierarchy. Chimpanzees and bonobos also display dominance hierarchies, with a lot of emphasis placed on female social rank, particularly among bonobos. Despite the wide variation in sociality among these species, one thing is consistent: where there is social rank, aggressive dominance is the winning attribute. If an alpha can successfully defend resources, whether territory, food or mates, it can dominate a primate society. Access to more resources translates into having more surviving offspring than others, which is the only measure of success for evolution by natural selection.

Among our own ancestors – members of the genus *Homo* – the story is different. Research in anthropology and primatology suggests that, as early people evolved more complex social structures, they did something unseen in other primates: they domesticated themselves. Once they had the cognitive sophistication necessary to create weapons, along with the intelligence required to form alliances, they could fight the large, angry dominants that ruled over their social groups. The primatologist Richard Wrangham at Harvard University argues that this profoundly shaped human society because, along with eliminating the alphas, our ancestors also selected against the human trait of aggression. As a result, humans became more cooperative, and their societies became more egalitarian.

Insidious success

But if that is the case, how do we explain the undeniable and growing inequality in today's societies, where huge amounts of power and money are concentrated among a small number of people, with the problem particularly pronounced in major economies such as the US, the UK and China? Some researchers argue that humans are not egalitarian by nature, but that living in small, close-knit groups of hunter-gatherers – as people did before the dawn of agriculture – suppressed our tendencies to form dominance-based hierarchies. They see a U-shaped curve of human egalitarianism. The point we started from – which looked a lot like the social structures we see in other great apes – is where we have ended up again, with the middle of the U showing a brief flirtation with social equality.

I agree that we aren't naturally egalitarian. In fact, I am not convinced that human societies were ever egalitarian. As anthropologists point out, even living hunter-gatherers have some brutal practices, such as infanticide. But, for me, the explanation for our current unequal circumstances lies not in our ancestors having selected against aggression, but in how the elimination of despotic alpha males allowed other, arguably more insidious people to succeed.

Once humanity was free of the strong grip of strict dominance hierarchies led by alpha ›

males, success in social groups would have become more about skilful manoeuvring within communities. This led to the rise of a particular kind of social intelligence called Machiavellian intelligence, which entails the cunning manipulation of others. In the language of evolutionary biology, we have a cooperation dilemma: there are situations where it is in our interest to work with others, and there are situations where it is not. And, as anyone who has watched an episode of *The Traitors* will be aware, the need to pull together and the need to betray can come into conflict. As a result, overt rivalry was superseded by what I call "invisible rivalry" – the ability to hide selfish, competitive or exploitative intentions while maintaining the appearance of a cooperative nature. In other words, we evolved to compete in a cooperative world.

Support for this idea comes from the size of the human brain. All primates have large brains relative to their body size, and ours is exceptionally big. The social brain hypothesis suggests that these large brains evolved to help individuals manage their unusually complex social systems. Of course, cooperation is part of this, but it can't be the whole story. Consider ants, which, in terms of numbers and pervasiveness, are probably the most successful group of species on Earth. They are eusocial, which means they cooperate so fully that they seem to act as a single organism. Yet their brains are tiny, and everything they need to work together is programmed within them genetically. So, you don't necessarily need a big brain to cooperate – but you do need one to compete strategically. Indeed, research suggests that social competition is what best explains the evolution of our enormous brain compared with the big brains of other primates.

To paraphrase Aristotle, we are political animals – not merely social ones. We strategise within our societies to maximise our success, whether that is defined in terms of money, power, mating success, hunting prowess or any of the other qualities associated with prestige around the world. To do so effectively, we evolved to not just be smart enough to cooperate, but to cooperate selectively – and to betray others when it suits us, or even just when we can get away with it.

Studies by economists and psychologists illustrate this. For example, in one set of experiments, participants were paired in a cooperation game in which one person was given $10 and the choice to share it with the other (or not). A lot of research shows that in these circumstances, people generally give some money to their partner, often splitting the pot equally, even when there is no obvious punishment for betraying them. But this time, the researchers gave some participants another option: they could take less money and leave the game without their partner ever knowing that they had been involved in a cooperation game. About one-third of participants took this option. It was as if they were happy to pay to have their betrayal left unknown.

Experiments like this tell us a lot about the human psyche. In social interactions, we often need to be able to predict what others around us are going to do – to learn where to place trust effectively, to win trust when we need it and to hide betrayals of trust on our own part. These abilities require empathy, emotion, language and, perhaps, as some of my colleagues argue, consciousness. Yet those same abilities, and that same intelligence, have a dangerous downside. Our evolved proclivity for maximising resources leads us to exploit those around us – and some people are so effective at deception that they risk damaging their societies. Modern, extreme inequality is an example of this process in action. So too are past political upheavals leading to degradation of the rule of law – and sometimes the fall of civilisations. The Roman Republic, for example, collapsed because of a tremendous internal struggle for power, culminating in Julius Caesar's Machiavellian machinations, eventually leading to autocracy.

So, our dual cooperative-competitive nature means that we face an enemy within that may

ADAM GUZ/GALLO IMAGES/GETTY IMAGES

"We evolved to compete in a cooperative world"

The Maasai people have a system called *osotua* whereby they give cattle to others in need

SIEGFRIED MODOLA/GETTY IMAGES

ZOONAR GMBH/ALAMY

Left: Religion is used by societies to promote cooperation. Above: Capitalism is seen by some as the cause of inequality

bring down society. And this is where the analogy with cancer arises. Humanity's long history of living with the disease means we have evolved biological mechanisms to reduce the risk it poses. Many reactions at the cellular level, including attacks by immune cells and programmed cell death, evolved to help our bodies fight off cancers, as well as other, external threats to our survival. It is this stalwart immune system that explains why, although mutations occur all the time and we are frequently exposed to viruses and bacteria, these often don't lead to symptoms or illness. Similarly, the threats to our social groups posed by the evolution of invisible rivalry led us to develop practices, behaviours and institutions to maximise cooperation and thwart our Machiavellian tendencies. In my new book, *Invisible Rivals: How we evolved to compete in a cooperative world*, I call this our cultural immune system.

Cultural evolution

Religion is one institution that can function in this way. Religious teaching can promote cooperation among everyone who practises it – and this is one possible reason that the Golden Rule, often summed up as "treat others as you would like to be treated", is found independently in scriptures across the world. People who believe these scriptures – who internalise them, as anthropologists say – are more likely to help fellow members of their group.

Everywhere anthropologists look, they find other practices and institutions that bolster cooperation at the local level. In cultures that rely on fishing, there are strong norms against over-fishing, which would deplete the stock for everyone. Where people are dependent on hunting, there are strict rules about how meat is shared and who gets credit for a kill. The Maasai people of Kenya and Tanzania have a relationship framework called *osotua*, rooted in need-based sharing partnerships and relying on mutual help in hard times. For example, if someone needs cattle because theirs have all died, another member of the group will help, not because they get anything directly in return, but simply because their neighbour's needs are greater at that time. This creates a special bond – *osotua* translates as "umbilical cord" – and treachery is rare because the bond is seen as sacred.

Across the world, social norms that guide behaviours have evolved, and they have been refined over thousands of years of trial and error through cultural evolution. However, just as cancers find ways to evade our immune systems, so some individuals use their Machiavellian intelligence to subvert the group's social norms for their own benefit. This is trickier to do in small-scale societies where people all know each other, making rule-breakers easier to detect and punish. But as societies grew over the past 10,000 years, so did opportunities to act selfishly. Agricultural networks, cities and, finally, nation states made deception much easier to pull off, because it is easy to cheat more people without getting caught in a group where it is impossible to know everyone personally.

It is this lethal combination of opportunity and invisible rivalry that makes the question of whether humans are cooperative or competitive so relevant today. To fight the enemy within society, we need to understand that both traits are in our nature, and that we evolved to apply whichever suits us best. Thinking that we are either one or the other leaves us vulnerable to facile arguments about how we should structure society. If we are purely selfish, it follows that society should focus on heavy policing and punishment of freeloaders, including those in power. But believing that we are intrinsically altruistic is equally detrimental because it risks ignoring the threat posed by rampant self-interest.

Suppressing humanity's Machiavellian side is certainly harder in large-scale societies. But there are basic ways that we can boost the cultural immune system, much like how we can improve our biological immune systems through healthy lifestyles and vaccination. The key, I believe, is to learn more about the social norms that small-scale societies have evolved to help them thrive and stave off opportunistic cheaters and then use this knowledge to create policies that promote cooperation at a higher level. For example, within our own communities, we can look to cultures that promote systems like need-based transfers and others that have found ways to share resources more equitably.

But this isn't going to happen until we first recognise the problem that invisible rivalry poses. In my view, the best way to do that is through education. We are all part of the cultural immune system. If we understand our evolutionary heritage, we will be alert to the danger that freeloaders pose to society and place our trust more discerningly – much as the body's defence system learns to recognise the agents associated with cancers and other diseases to deal with them. Crucially, we also need to recognise that cooperation is best for everyone in the long term.

A small proportion of people at the most competitive end of the spectrum will always try to game society. We must work together to stay one step ahead of humanity's opportunistic nature. Without beliefs, norms and a proper understanding of human nature, we are at the mercy of our selfish biological heritage. Evolution has made us this way, but we can learn to overcome it. ▮

Jonathan R. Goodman is a social scientist at the Wellcome Sanger Institute and Cambridge Public Health, UK. *Invisible Rivals* is out now

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The back pages

Puzzles
Try our crossword, quick quiz and logic puzzle p45

***Almost* the last word**
Why not hover above Earth until it rotates to your destination? p46

Tom Gauld for *New Scientist*
A cartoonist's take on the world p47

Feedback
Academic insights into human-robot intimacy p48

Twisteddoodles for *New Scientist*
Picturing the lighter side of life p48

The science of exercise

Hold it right there!

Isometric exercises like wall squats are gentle on your body, but have all sorts of surprising benefits, discovers **Grace Wade**

Grace Wade is a health reporter for *New Scientist* based in the US

IN MY last column, I explained why isometric exercises – which involve squeezing and holding a muscle in a fixed position – are especially effective at lowering blood pressure. Since then, I have started incorporating them into my own workouts. This got me wondering: do these exercises offer any other benefits?

As it turns out, yes – and some were unexpected. Isometric moves such as planks (pictured) and wall squats can reduce pain, prevent injuries and enhance fitness in a surprisingly efficient way. In fact, most people could probably benefit from adding them to their workout routine.

One of the clearest advantages of isometric moves is that they build strength without much movement, making them less physically taxing than more dynamic workouts. And they are effective: a review found that 42 to 100 days of isometric training increased muscle strength by up to 92 per cent.

Those strength gains can also be quite targeted. Athletes often use isometric exercises to get stronger at the toughest part of a movement, such as the bottom of a squat. This can improve their overall performance, with researchers discovering that isometric training increased endurance more than a jumping-focused workout.

Because they are gentler on the body, isometric exercises can also easily be tacked onto the start or finish of your regular workout, helping you squeak out extra gains. They are especially great warm-ups, with studies finding they reduced post-workout muscle soreness without affecting running performance. That is in contrast to static stretching, which had no effect on muscle soreness and actually impaired performance.

SUTULASTOCK/SHUTTERSTOCK

Adding a few isometric moves to your warm-ups may also help prevent injuries. While eccentric workouts – which emphasise slow, controlled movements in the lowering phase of an exercise – are commonly used to prevent hamstring injuries in football players, isometric exercises are more effective, according to research.

It isn't clear why, but it could be that isometric moves "wake up" signalling pathways between nerves and muscles, making the latter more responsive during exercise. This may help correct muscle imbalances, a common cause of injury.

The benefits aren't exclusive to athletes, either. A review this year showed isometrics significantly reduced pain and strengthened muscle in people with knee osteoarthritis. Because they are low-impact, these exercises are ideal for beginners or people with limited mobility due to injuries.

Given their benefits, isometric exercises have earned a regular spot in my workout routine. And, because they don't require any equipment or jumping, I can do them almost anytime, anywhere. ▮

These articles are posted each week at newscientist.com/maker

The science of exercise appears monthly.

Next week
Dear David

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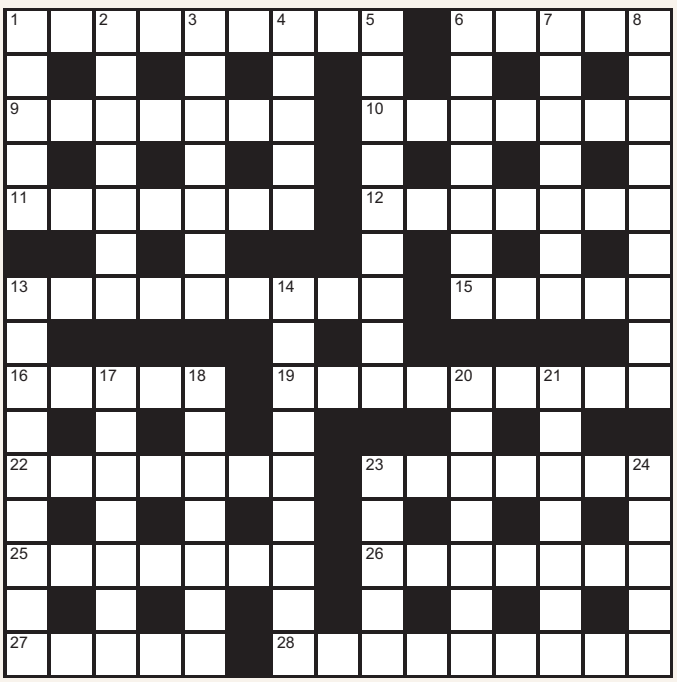
Quick crossword #187 *Set by Richard Smyth*



Scribble zone

Answers and the next cryptic crossword next week

ACROSS

1 Smaller than an atom (9)
6 Small bone of the middle ear (5)
9 Write code (7)
10 Launch (7)
11 Female of the species *Panthera leo* (7)
12 Least short (7)
13 Opioid brand name (9)
15 Freight ship with no fixed schedule (5)
16 Most distant point in the orbit of a planet (5)
19 2010 sci-fi film by Christopher Nolan (9)
22 Paul ___, Nobel prizewinning German scientist (7)
23 Soil or silt deposited by flowing water (7)
25 Total (3,2,2)
26 Type of muscle (in the shoulder, perhaps) (7)
27 Mistake (5)
28 Deformed sphere (9)

DOWN

1 Part of the calyx of a flower (5)
2 Scientific study of life (7)
3 Underwater missile (7)
4 Viral disease associated with parotitis (5)
5 In a severely withdrawn state (9)
6 Key component of a Rorschach test (7)
7 Bacterial infection of the intestine (7)
8 Fastening device patented in 1849 (6,3)
13 As a mean, say (2,7)
14 Femur (9)
17 1989 Capcom arcade game (7)
18 Butterfly in the family Hesperiidae (7)
20 Obsolete term for a small computer (7)
21 Conceived or grown using labware (2,5)
23 Concerning the ears or hearing (5)
24 Pungently bitter (5)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #310
set by Corryn Wetzel

1 Which animal has the largest brain by volume?

2 Name the chemical compound known as "laughing gas".

3 When did Apple debut its first desktop computer, the Apple 1?

4 What is another name for the vomeronasal organ?

5 Which planet has the fastest recorded wind speeds in the solar system?

Answers on page 47

BrainTwister
set by Alison Kiddle
#81 Consecutive squares

Can you find three consecutive positive numbers such that the square of the first plus the square of the second is the square of the third?

How about five consecutive positive numbers such that the squares of the first three add to give the sum of the squares of the last two?

And can you identify seven consecutive positive numbers such that the squares of the first four add to give the sum of the squares of the last three?

Answers next week

Go for a spin

If Earth turns at (say) 1000 kilometres per hour at London's latitude, why not, when you want to travel, just go straight up and wait for your destination to rotate around until it is beneath you?

Herman D'Hondt
Sydney, Australia
Let's start by considering the following question: why don't you face a 1000 km/h wind when standing still in London? The original question overlooks the fact that Earth's atmosphere rotates along with the planet. If it didn't, you would indeed have to face such winds. At the equator, the wind would be even stronger, a supersonic 1600 km/h. So if you hover above London, the air will carry you along at 1000 km/h and you will go nowhere.

You could, of course, go straight up until you are out of the atmosphere – say 100 km up – and hover there. In that case, assuming your destination is at the same latitude as you, your suggestion would work.

To hover at 100 km, large amounts of propellants are needed. First you need fuel to get that high. Richard Branson and Jeff Bezos can tell you how much fuel their "spaceships" use to get there and fall back. Then you would need even more fuel to hover there while waiting for your destination, and more fuel again to accomplish a soft landing there.

> **"You could, of course, go straight up until you are out of the atmosphere, say 100 kilometres up, and hover there"**

Branson's SpaceShipTwo flights cost upwards of $450,000 per seat. While Bezos hasn't revealed the cost of a flight on Blue Origin, the deposit alone is $150,000.

Believe me: airlines charge much less than that for a flight!

SHUTTERSTOCK/NICOLETA IONESCU

Better out than in: Is it better to let a burp (or a fart) out, or keep it in?

This week's new questions

Excess air **Is it better to keep a fart or a burp in, or let it out?** ***Paul Douglas****, Wellington, New Zealand*

Story time **How does the experience of reading a good novel differ from listening to the same story on audiobook? Are different parts of the brain engaged?** ***Jo Howard****, St Ives, Cornwall, UK*

Rachael Padman
Newmarket, Suffolk, UK
The question appears to assume that it is easy to hover above a rotating planet. However, Earth drags its atmosphere along with it, so the would-be traveller is faced with a 1000 km/h sidewind, and the only way we know to counter that is in a commercial airliner.

The proposed travel path is more or less exactly what happens if you fly west along a line of constant latitude, since airliners can almost (but not quite) keep pace with Earth at 51° north.

Of course, this means that to get to, say, Vancouver from London, you need to spend a lot of time waiting while the North Atlantic and Canada rotate beneath you. That will take around 8 hours. You will observe that it is much the same solar time there as when you left the UK. To get to Kyiv, it might be easier to simply fly east.

If the assumption is that you somehow wait out the journey above the atmosphere, then it is hard to see how to do this. There is no stable orbit where a satellite is stationary directly above London, so maintaining its position would require continuous thrust – and, as such, the burning of fuel.

If you are prepared to allow the "hover position" to move in latitude, maybe you could sit at one of the Earth-Sun Lagrange points, L1 or L2, but those are 1.5 million km from Earth and the travel time to and from there, not to mention the energetic requirements, would more than outweigh any potential advantages.

Hillary Shaw
Newport, Shropshire, UK
For the same reason that on a train doing 72 km/h, or 20 metres per second, with the restaurant car 40 metres behind you, you can't just jump up for 2 seconds and get there. You have the same momentum as the train does.

Imagine the chaos if you could, hurtling back down the train at 72 km/h. Similarly, imagine the chaos on Earth if airborne things didn't have a (similar) angular momentum to the rotating Earth below. Birds, if there were any, would shoot east at 1000 km/h as soon as they took off. But the air and sea's surge eastwards would mean there could be no life, bird or otherwise. We'd have 1000 km/h hurricanes and 1000 km/h tidal waves sweeping across land (at European latitudes).

Air masses move east when heading away from the equator, into regions of slower rotation, and west if they are moving towards the equator. This is the Coriolis effect, which has a major influence on our weather. But it would be very inefficient for humans to travel this way. To get from London to Warsaw by the Coriolis effect, you'd need to fly north to the Arctic and then south again, getting your timing right so you land in Poland.

It's probably easier just to go via Germany.

Bryn Glover
Kirkby Malzeard, Yorkshire, UK
This idea for easier travel sounds good, but for one small glitch.

If the Earth is travelling at 1000 km/h, then so is the questioner, standing on it. So in order to "go straight up", they will need to slow their velocity to a relative zero.

The best way to do this is to get in a jet plane and power themselves backwards – which, by coincidence, is exactly how people do it already.

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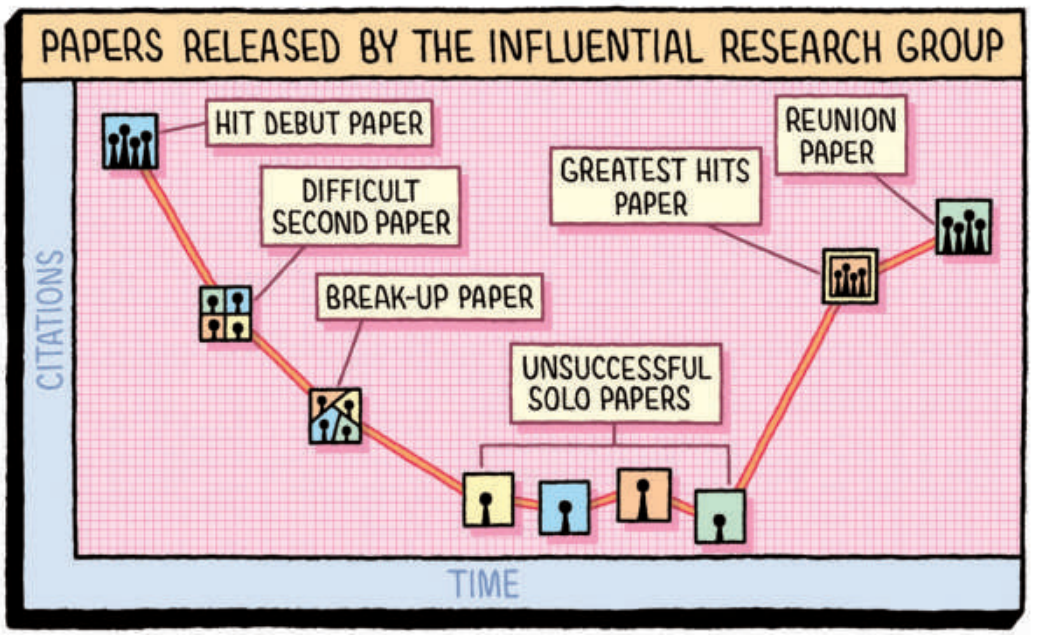
Tom Gauld
for New Scientist



Lunar glow

Does a full moon reflect enough sunlight to drive photosynthesis? Is there a cut-off point below which the process simply stops?

Mike Follows
Sutton Coldfield, West Midlands, UK
Some plants can photosynthesise using nightglow, traditionally comprising moonlight, starlight and the light reflected from planets. Increasingly, artificial light at night, known as light pollution, contributes to this background illumination. However, as plants already receive ample sunlight during the day, there has been little evolutionary pressure to depend on nightglow as a primary energy source.

The currently accepted theoretical light intensity required for photosynthesis is approximately 6 quadrillion photons (6×10^{15}) per square metre per second. This may sound substantial, but it is about 50,000 times lower than the average daytime photosynthetically active radiation (PAR), but about 10 times the photon flux from full moonlight. PAR, which has wavelengths between 400 and 700 nanometres, constitutes approximately 37 per cent of total solar energy.

A year-long research study recorded photosynthesis by microalgae at depths of up to 50 metres beneath Arctic sea ice, shortly after the polar night, despite illumination just four times the minimum level required.

In another extreme case, green sulphur bacteria (GSB1) were discovered at a depth of 2500 metres off Mexico's Pacific coast, surviving on the faint infrared glow from hydrothermal vents.

Understanding photosynthesis under low-light conditions may help extend growing seasons in high-latitude agriculture sites and inform strategies for crop cultivation in space or extraterrestrial habitats.

"A year-long research study recorded photosynthesis by microalgae at depths of up to 50 metres beneath Arctic sea ice"

Only polite

Do all languages have the equivalent of "please" and "thank you"? Why are these words so important to us? (continued)

Sam Edge
Ringwood, Hampshire, UK
In response to Mike Kelly's answer to this question: while, as he says, the Danes don't have a literal word for the implied contraction of "if it pleases you" ("please"), my Danish partner uses another word in the same context: "*værsgod*". This is (very approximately) pronounced "verse-go".

This is an implied contraction of "would you be good as to" or "if you'd be so good".

So, "Two beers, please" becomes "*To øl, værsgod*", as I have used repeatedly on our many visits to Jutland! ▮

Answers

Quick quiz #310 *Answers*

1 The sperm whale (*Physeter macrocephalus*)
2 Nitrous oxide (N_2O)
3 1976
4 Jacobson's organ
5 Neptune

Cryptic crossword #165 *Answers*

ACROSS 1 Stratosphere, **8** Never, **9** Haptics, **10** Polaris, **12** Crimp, **13** Embody, **15** Stigma, **18** Logic, **19** Inhaler, **21** Bear hug, **22** Meson, **23** Ig Nobel prize

DOWN 1 Synapse, **2** Rival, **3** Tor, **4** Schist, **5** Hopscotch, **6** Railing, **7** RSVP, **11** Radicchio, **14** Big bang, **16** Arrange, **17** Single, **18** Lobo, **20** Lassi, **22** Mop

#80 Iccanobif numbers *Solution*

The first difference is the 8th term: it is 21 for the Fibonacci sequence and 39 for Iccanobif.

The two terms with four digits are the 12th (1053) and the 13th (4139).

Term 21 is the first to decrease. The 20th term, 17354310, is followed by 9735140.

Electric dreams

Recently, Feedback was delighted to peruse the raciest conference invitation we have ever received. We get a lot of conference invites from organisers labouring under the delusion we are doing something akin to science journalism, and they are mostly a little prosaic: what's new in G-protein signalling, more findings about the biology of molluscs, that kind of thing. But not this one, about an upcoming event in Shaoxing, China.

Here is the opening line: "From its groundbreaking inception in London to its spectacular evolution in the vibrant heart of China, the Love and Sex with Robots Conference is gearing up for its most thrilling chapters yet: its landmark 12th International edition, scheduled for June 2026."

Before you start to imagine a sort of cybernetic Sodom and Gomorrah, remember: this is an academic conference, albeit one with TED Talk levels of hype. We are told to "prepare for a dazzling convergence of visionary scientists, renowned researchers, and revolutionary thinkers who are redefining human intimacy through cutting-edge robotics and AI". Furthermore, "attendees will experience mind-blowing revelations, groundbreaking demonstrations, and provocative discussions that boldly explore the future of love, companionship, and technology".

Elsewhere, the invite describes the conference as an "electrifying event": we trust not literally. Then again, it encourages "practical demonstrations showcasing functional robotic technologies, software, or innovative interaction concepts", so who knows?

Studying the conference website, Feedback learned it has a "Supreme Council" that "guides the conference vision and direction". All five of its members are men: make of that what you will. The "Supreme Leader" (we promise we aren't making this up) is one David Levy, who long-time *New Scientist* readers may recall as the author of the 2007 book *Love and Sex With Robots*. Our reviewer said Levy's "enthusiasm for the carnal aspects of robotics leads him so often into the absurd that it's hard to take his arguments seriously".

Still, the conference organisers clearly know what they're about. The invite announces that "this is the conference the whole world will be talking about", and here Feedback is, talking about it.

Twisteddoodles *for New Scientist*

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Drone defence

In a recent *New Scientist*, contributor David Hambling asked: "Can any nation protect against a Ukraine-style drone-smuggling attack?" (21 June, p 8). Hambling discussed building physical barriers like nets or "hardened aircraft shelters", using electronic jamming to disrupt the drones, and "kinetic measures, otherwise known as shooting down the drones" – ultimately concluding that it was all a bit difficult.

Which is all very well, but reader Robert Bull points out that the answer was right there in the first expert cited in the story: security and counterterrorism professional Robert Bunker.

Cheesed off

US news editor Sophie Bushwick sent Feedback a truly chilling press release: "Cheese may really be giving you nightmares, scientists find". Please, we thought, for the love of all that's dairy, let this not be true. We have so few joys in life. Don't delete the cheeses.

The press release led us to a study in *Frontiers in Psychology*, titled "More dreams of the rarebit fiend: Food sensitivity and dietary correlates of sleep and dreaming". If you are confused by the reference to rarebit, you may be insufficiently Welsh: rarebit, the authors explain, is "a spicy melted cheese toast".

The authors wanted to know if certain foods really do affect your sleep, as folk mythology would suggest. They surveyed 1082 people online and found that about a fifth believed that certain foods improved or worsened their sleep, and a smaller fraction believed they affected dreams. At this point, Feedback was mildly unimpressed, because all this demonstrates is that some people believe that some foods affect sleep, which, we cannot emphasise strongly enough, isn't the same as it being true.

However, the paper goes deeper – or perhaps off the deep end. The researchers found a strong link between reports of having worse nightmares and reports of lactose intolerance, leading them to suggest that lactose-intolerant people are having more nightmares because of the painful symptoms they experience after eating cheese.

At this point, Feedback facepalmed so hard we left a mark. Lactose is, of course, the sugar found in milk, which, until relatively recently, could only be digested by babies. In the past few millennia, some populations evolved the ability to digest lactose as adults: those without this trait are lactose-intolerant, and drinking milk makes them agonisingly poorly.

The thing is, most cheeses are quite low in lactose. The process of cheese-making removes the lactose, which might be why early pastoralist groups invented it: cheese was a way to guzzle dairy without the subsequent anguish. It therefore seems unlikely that a bit of cheese before bed would cause a lactose-intolerant person to have a terrible night.

What a journey we've been on. You thought this was just a funny story about cheese, but it's actually a stealth launch for a new recurring item: Feedback's Pet Peeves, in which we will outline the many trifling hills upon which we are prepared to die. You have been warned.

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